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26

ANNALS

OF THE

SOUTH AFRICAN MUSEUM

VOLUME XXII

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DESCRIPTIONS OF THE PALAEONTOLOGICAL MATERIAL COLLECTED BY THE SOUTH AFRICAN MUSEUM AND THE GEOLOGICAL SURVEY OF SOUTH AFRICA

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VOLUME XXII.

DESCRIPTIONS OF THE PALAEONTOLOGICAL MATERIAL COLLECTED BY THE SOUTH AFRICAN MUSEUM AND THE GEOLOGICAL SURVEY OF SOUTH AFRICA.

PART I, *containing*:—

SEMPER ALIQUID NOVI AFRICA AFFERT

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SOUTH AFRICAN MUSEUM

VOLUME XXII.

1. *On Some South African Fossil Woods.*—By JOHN WALTON, M.A., Lecturer in Botany at the Victoria University of Manchester.

(With Plates I–III.)

IN 1923, at the request of the late Dr. Kidston, I undertook the examination and description of a collection of South African fossil woods which had been sent to him by Dr. du Toit, and which he had been unable to examine himself owing to pressure of work. I remember the kindness with which Dr. Kidston on a previous occasion allowed me to investigate and describe some new specimens of *Rhexoxylon*, and record this as another of his many acts of kindness to me. I am much indebted to Dr. A. W. Rogers for sending me the fine specimen of *Rhexoxylon priestleyi* and for the effective interest he has taken in this work. I also thank Professor Seward for entrusting to me the investigation of some fossil woods which had been sent to him from the Albany Museum, and which it has been my privilege to examine. I express my thanks to Mr. W. N. Edwards of the British Museum for facilitating my examination of the specimens in his charge and for information regarding localities.

These collections together yield an assortment of species from widely different geological horizons and of widely different affinities: it is therefore my intention to deal in these accounts with each species separately on its own merits, and to discuss points of general interest as they arise. I have paid particular attention to *Dadoxylon arberi*, Seward, as it is apparently of wide distribution and because the type specimens were never adequately figured. The discovery of a well-preserved specimen of *Rhexoxylon priestleyi*, Seward sp., is also dealt with, and other new species of woods are described. I have

adopted the classification of the zones of the Karroo System recognised in the Cape Province, and the correlation of this succession with that elsewhere, put forward by Dr. A. L. du Toit in 1918.* When terms relating to the European succession are used, it is to be understood that I refer to this correlation.

Dadoxylon arberi, Seward.

(Plate I, figs. 1–6 (1089 S.A. Mus.).)

Syn. *Dadoxylon australe*, Arber. 1905.
,, ,, ,, Warren, 1912.
? ,, cf. *angustum*, Felix. Halle, 1911.
,, *nicoli*, Seward. 1917.
,, *arberi*, ,, 1919.
,, *bakeri*, Walton. 1923 (in Seward and Walton).

Several specimens belonging to this species have been examined in the course of my investigations. The following description is based on the most complete specimen, reference being made to the others when necessary.

The specimen (1089 S.A. Mus.) consists of a large block of silicified wood. The pith and primary tissues are crushed so that the arrangement of the latter is destroyed, but the secondary wood and small portions of the primary tissues are well preserved. No tissues external to the secondary wood are represented. At one side of the specimen a branch was given off, the diameter of the pith of which is 2 mm.

The pith of the main axis consists of large, isodiametric, thin-walled cells, with occasional long, secretory elements (the longest observed being 0·8 mm.) orientated in a longitudinal direction (Pl. I, fig. 4). In transverse section they are seen to be narrower than the pith cells, and have a dense black inclusion of carbonaceous (?) material in the centre of the lumen. The crushing action has effected a separation of the pith into two portions, but judging by the size of these, it must have had a diameter of at least 5 mm. in its uncrushed state, assuming that it was originally circular. In transverse section there appear to be isolated groups of large tracheids lying near to the periphery of the pith at one or two places. These may represent the leaf-trace system, or, on the other hand, they may be only displaced strands of secondary xylem.

The secondary xylem, in transverse section (Pl. I, fig. 1), is seen to consist of radially seriated tracheids and uniseriate medullary rays.

* Du Toit, 1918, p. 36.

There are clearly defined, concentric, growth rings. Each ring is composed of an inner wide zone, in which the tracheids have wide lumena (the early wood), and a somewhat narrower zone, sometimes very narrow, of tracheids which are much narrower radially, exhibiting also smaller lumena (the late wood). The early wood structure gradually merges into that of the late wood, but there is an abrupt change from the last elements of the late to the first of the early wood of the succeeding ring. In some of the rings (compound rings, *cf.* Barber *) there are zones of elements of the late wood type occurring in the middle of the early type of wood (Pl. I, fig. 1, *a*). These do not usually † show any abrupt change to the elements lying internally or externally to them, and do not form a complete concentric ring. In one transverse section it was possible to determine the radial extent of five normal rings: starting from the pith, their thicknesses were consecutively 5, 12, 12, 6, and 12 mm. The first zone of radially seriated elements round the pith consists of tracheids which, in transverse section, appear to be ordinary early wood elements. The wide elements in this zone, however, are seen in longitudinal section to have spiral and then reticulate thickening, and finally multiseriate bordered pits (Pl. I, fig. 2). The innermost spirally thickened elements are protoxylems. In some sections it was possible to measure considerable lengths of individual tracheids: Tracheid length, at least 2·7 mm. in some elements; radial breadth of tracheid, early wood, 30–40μ; radial breadth of tracheid, late wood, as low as 8μ; tangential breadth of tracheid, early wood, 30–40μ; tangential breadth of tracheid, late wood, 30–40μ.

The tracheids are pitted on the radial walls only (Pl. I, figs. 3 and 6). In the large tracheids the pits may be 4-seriate, with pits in contact and flattened. The pits may also be arranged in groups which do not appear to bear any relation to the medullary ray cells. Sometimes the pits, even when 4-seriate, are loosely arranged and have circular borders. When biseriate the pits may be in two slightly separated files (*cf.* Pl. I, fig. 3, top right-hand corner), the members of one file either opposite to or alternating with those of the other. Isolated pairs of oppositely placed pits are very characteristic, and when uniseriate the pits are more usually distant. The

* Barber, 1898.

† In one the change is abrupt, and at this point is indistinguishable from an ordinary ring. The ring extends, however, quite a short distance and fuses at each end with the late elements of the normal ring, from which it is separated by a maximum of six large elements.

usual diameter of a pit is about 10μ, but it is found to vary from 8–12μ. The pore is typically centric and circular, and is from two-fifths to one-fourth the diameter of the pit; in the very narrow tracheids the pore is narrowly elliptical and oblique. There is no indication of a torus in any of the pits examined. Rims of Sanio are absent. In some of the larger tracheids, transverse marks can be seen between some of the groups of pits. These marks are, I think, due to partial disorganisation of the tracheid wall, and cannot be interpreted as true rims, for they are not seen in the best preserved specimens.

Xylem parenchyma, other than the medullary rays, has not been detected in any of the specimens.

The medullary rays are typically uniseriate, but biseriate rays and partly biseriate rays are quite frequent (Pl. I, fig. 6). The rays are from 1–20 cells in height (height of individual cell 26μ av.). The length of a ray cell is 130–240μ radially. There are 1–9 circular to elliptical, apparently simple, pits in the field.* The major axis of the pit is sometimes slightly inclined to the horizontal (Pl. I, fig. 5). The dimensions of the pits vary from $3 \times 4\mu$ in the late wood to $6 \times 8\mu$ in the early wood.†

Locality.—Klipgat, Murraysburg Dist., Cape Province.

Horizon.—Upper part of Lower Beaufort Beds.

Discussion.

Arber ‡ described some fossil wood from Australia represented by sections in the Nicol Collection at the British Museum, and instituted for them the name *Dadoxylon australe,* unaware that Crié had previously used the name for a New Caledonian species. Professor Seward, who called attention to this fact, unfortunately used the name *D. nicoli,* but this must be abandoned as Carruthers § had already used the name *Araucarioxylon nicoli,* although no description or figure is given, for a wood from the Bowen River Coalfield. Later Seward proposed the term *Dadoxylon arberi,* which must now be used for the wood originally described by Arber and named by him *D. australe.*

In placing these woods in the species *Dadoxylon arberi,* Sew., it is definitely intended to imply that no account is taken at present of

* Cf. *Protopitys Buchiana,* Goeppert (Upper Devonian), Solms-Laubach, 1893, Bot. Zeit. Jahrg., vol. li, p. 197.

† It is not possible to determine whether the wall of the ray cell is itself pitted or whether, as in the modern Araucaria, it is unpitted.

‡ Arber, 1905.

§ Carruthers in Etheridge, 1880.

other structures than those of the secondary wood. In all the woods enumerated above the primary tissues are either not represented (as in the co-types), or else they are too badly preserved to be of any use as criteria for distinguishing one specimen from the other. When any wood with well-preserved primary structure and possessing the *D. arberi* type of secondary wood is found, it must be given a distinct name. As the result of examining the types of *Dadoxylon arberi,* Sew. (*D. australe,* Arber), I am convinced that it is impossible to separate the secondary wood of *D. bakeri,* Walton,* from wood of this type. The description of the type specimens of *D. australe,* Arber, is, I think, misleading: for example, the pits in the field are not markedly oblique, nor are the tracheids very small, and the shortness of the tracheids is by no means a constant feature. I agree completely with Dr. Warren's † determination of the Natal Museum specimens (Nos. 11 and 219), which he very kindly sent to me for purposes of comparison. I cannot agree, however, that *D. arberi,* Sew., has such a large vertical distribution as he suggests.‡ He admits that the Cretaceous specimens, which he tentatively assigns to this species, are badly preserved, and I think that the evidence is in favour of the view that *D. arberi,* Sew., is, in South Africa, restricted to Permian strata (*vide* p. 7).

The presence of well-defined annual rings is of general occurrence in these Southern Hemisphere Permo-Carboniferous woods, and is a feature which has been much discussed, as some Palaeozoic woods from the Northern province are usually without rings. I do not propose to discuss this question here as it has been adequately dealt with elsewhere,§ but it is to be noted that one cannot tell in the case of a wood without distinct growth rings whether the absence is due to the effect of a uniform climate or whether it is merely the result of uninterrupted growth.||

There is variation in the pitting of Arber's types, but this is not greater than what is found in individual specimens. There is no doubt that the same type of secondary wood is common to Permo-Carboniferous strata in Australia, South Africa, and the Falkland Islands.¶ Among the Falkland Island specimens one ** shows quadriseriate pitting in many of the tracheids, and quadriseriate pitting is also found occasionally in the South African specimen described above. Such a range is not unknown in species of living plants (*cf.* Araucaria

* Walton, in Seward and Walton, 1923.

† Warren, E., 1912.

‡ *Ibid.*, p. 350.

§ Antevs, E., 1917, pp. 359–360.

|| *Ibid.*, p. 364.

¶ Halle, 1912.

** In Camb. Bot. School Col., No. 856.

spp. Sew., Fossil Plants, iv, fig. 691). *Dadoxylon* (*Araucarioxylon*) *Daintreei*, Chapman sp.,* has secondary wood which resembles that of our specimens very closely. It has, however, distinctly oblique pores in the bordered pits, and has occasionally six series of pits on the radial walls of the tracheids. It is also noteworthy that *D. Daintreei* has a much narrower pith than *D. arberi* (1089 S.A. Mus.). In structure *D. arberi*, Sew., is very similar to the secondary wood of *Araucaria* and *Agathis*, and I have seen sections of the latter which in a fossilised condition would be distinguished only with difficulty from *D. arberi*. In the Araucarineae, however, the pits are not so frequently distant or oppositely placed. The pitting in the field in *Agathis* is sometimes very like that of *D. arberi* (Pl. I, fig. 5). It must be remembered that the walls of the ray cells are themselves unpitted in these two living genera. The nature of the transitional region (Pl. I, fig. 2), with closely packed multiseriate pitting followed later by the formation of tracheids with oppositely placed and often distant pits, might be considered to support previous arguments, which are in favour of the greater age of the Araucarian compared with the Abietinean type of plant.† It also suggests that the latter has been derived from the former, as do also Jeffrey's ‡ fossil Abietinean-Araucarian forms, according to Thompson. § I doubt whether *Araucariopitys*, Jeffrey, § exhibits any very characteristic Araucarian features at all. The main fact, on which its alliance to the Araucarians is based by Jeffrey, is the presence of pits in contact, and this alone seems to be insufficient. It is a pity that it was given a name suggesting an alliance about which so much controversy is possible. Torrey ¶ has instituted a new genus and species in *Voltzioxylon documense*: there is little evidence in favour of any connection with *Voltzia*, and in my opinion the wood is only referable to *Dadoxylon*. The fact that the pits are not compressed is not a serious objection, as it is a feature common in some of these Southern Hemisphere Dadoxyla (cf. *D. arberi*, Sew., *D. Pedroi*, *Rhexoxylon*, etc.). Torrey, in a diagrammatic phylogeny,** interpolates typical Abietineoid forms (*Protopiceoxylon* and *Protocedroxylon*) as an intermediate stage between the Araucarineae and the Cordaitales (Dadoxyla), an assumption for which there is little palaeontological justification. The fact remains that we have in *D. arberi*, Sew., secondary wood almost indistinguishable from Araucarinean found in Permian strata, from which period no Abie-

* Chapman, F., 1904, p. 320.
† Seward and Ford, 1906.
‡ Jeffrey, 1907.
§ Thompson, 1913.
|| Jeffrey, 1907.
¶ Torrey, R. E., 1923, p. 98.
** *Ibid.*, p. 98.

tinean types have been as yet recorded. Gothan asserts * that " Araucariten " with round pores to the bordered pits are unknown, and that in Palaeozoic plants they are rare. In view of this statement I examined the pits in this fossil very carefully and could distinguish by careful focussing where the wall of the tracheid was at an angle with the plane of the section, the round pore on each side of the bordered pit without any indication of a torus in the intervening space. I am therefore convinced that the round pore is an original feature of the bordered pits in this wood, which is in places very perfectly preserved.†

Horizons and localities of specimens which the writer has examined :

Horizon.	Locality.	Collection.
	SOUTH AFRICA.	
" Upper part of Lower Beaufort."	Klipgat, Murraysburg. Cape.	S.A. Mus. 1089.
" Beaufort "	Van Wyk's Vlei, Carnarvon, Cape.	Alb. Mus. 508.
" Natal Coal Meas." (Lower Beaufort).	Umkomaas Valley, Natal	Nat. Mus. 219.
,, ,,	,, ,, ,,	,, 11.
" Ecca Series "	Van Wyk's Vlei, Carnarvon, Cape	Alb. Mus. 2296.
" Base of Ecca "	,, ,, ,, ,,	S.A. Mus. 2947.
	? *D. arberi.*	
" Lower Beaufort "	Weltevreden, Philipstown Div., Cape	,, 4354.
	AUSTRALIA.	
? Newcastle Series	Australia	Brit. Mus. 51616.
,, ,,	,,	,, V8299.
	FALKLAND ISLANDS.	
Permo-Carboniferous	South Side Choiseul Sound	Brit. Mus., and Bot. Sch. Camb. 852–870.

Rhexoxylon priestleyi, Seward sp.

(Pl. II, fig. 11, and Pl. III, figs. 13, 14.)

Syn. *Antarcticoxylon priestleyi*, Sew., 1914.‡

Rhexoxylon priestleyi, Sew. sp., Walton, 1923.§

In 1914 Professor Seward ‡ described an interesting stem fragment from among the specimens collected by the Northern Party of Captain Scott's Second Expedition to the Antarctic Continent. The sample of fossil wood was discovered in a sandstone boulder found on a

* Gothan, W., 1905, p. 29, par. 4.

† *Ibid.*, p. 23.

‡ Seward, 1914.

§ Walton, 1923.

moraine on the Priestley Glacier (south of 74° S. lat.) to the west of the Ross Sea in South Victoria Land. The stem exhibits structures which are different from anything previously described in the fossil record, and the name *Antarcticoxylon priestleyi* was given to it. *Rhexoxylon priestleyi*, Sew. sp., as it must now be called,* as represented in the type specimen, is 3 inches in diameter and a foot long. Only the centre (poorly preserved) of the stem and secondary wood remain of what was possibly a much larger stem. Distinct rings of growth are present. Large tangential splits in the secondary wood, with small strands included in them of spiral, thickened elements are an important feature. Large rays with " leaf traces " are present. The traces are given off in spiral order, judging by the impression of the boulder. In the centre of the stem there are indications of a pith 3 mm. in diameter, with suggestions of large-celled, lacunar tissue and dark " patches of secretory sacs." Surrounding this tissue is a zone with numerous strands of spiral and scalariform tracheids. It was suggested that these formed a zone of centripetally developed xylem round the pith. The secondary wood is Araucarian in type.

In 1923 I was engaged in examining some specimens of the genus Rhexoxylon,* instituted in 1913 by Dr. Bancroft for a peculiar fossil plant axis from South Africa. Among the specimens which were found in the Molteno Beds of the Cape Province I distinguished a new species, *Rhexoxylon tetrapteridoides*, Wal. It is more complete than the original species of *Rhexoxylon africanum*, Bancroft, on which the genus was founded, and exhibits some important diagnostic features. The secondary wood has tangential cracks in which are placed numerous small secondary developments, which in favourable sections are seen to consist of spiral or scalariform elements. The curious cracks in *Antarcticoxylon* were at once recalled, and a careful comparison brought out many points of similarity. In *Rhexoxylon tetrapteridoides* there are large secondary developments of xylem in the perimedullary region, and I suggested that *Antarcticoxylon* might represent an early stage in the formation of typical *Rhexoxylon*, when as yet the " perimedullary growth has not started." *Rhexoxylon africanum*, Bancroft, is a still more complicated plant.

Recently a specimen of fossil wood, found many years ago, from the Molteno Beds at Catharine's Post, Dordrecht, was given to Dr. A. W. Rogers for investigation, and, thanks to the kindness of Mrs. Lloyd the finder and of Dr. Rogers, was handed over to me for

* Walton, 1923.

examination. On examining sections cut from the specimen I realised at once that it represented a *Rhexoxylon* indistinguishable from *Rhexoxylon priestleyi*, Sew. sp. The following description is based on an examination of the South African specimen, which is better preserved than the type of the species, and corroborates my attribution of the species to the genus *Rhexoxylon*. The fossil consists of a cylindrical block of brownish silicified wood with a central pith. One end of the block is weathered so that it resembles the water-worn end of a wooden pile from a jetty. Elongated depressions indicating the position of leaf or branch traces intersecting the outer surface of the block can be seen. They are arranged in an irregular spiral fashion. In transverse section the wood is clearly marked out by growth rings. Sometimes the rings appear to be composite * or compound, possessing minor darker bands in the early wood. These, on closer examination, are seen to be produced by a disturbance in the seriation of the tracheids, due to spaces which must represent the position of thin-walled cells, and into which the adjoining tracheids tend to bulge (Pl. III, fig. 13, *y*). These spaces were probably occupied by living cells, and are widely scattered in the secondary wood, but are occasionally found concentrated to a certain extent in definite zones concentric with the growth rings. The presence of such cells in *T. tetrapteridoides* was suspected by the writer, but their presence was not actually demonstrated in the account of that species.†

In one or two places there are tangential cracks in the secondary wood, with anomalous xylem developments (Pl. III, fig. 13) similar to those described in *Rhexoxylon tetrapteridoides*, Wal., and *R. priestleyi*, Sew. sp.‡ In the region figured (Pl. III, fig. 13) it will be noticed that the crack with the adventitious xylem strands occurs near the termination of a growth zone (*r*), separated by not more than three or four tracheids from the first row of succeeding early elements. This specimen confirms the suggestion that these developments are intimately connected with the activity of medullary ray cells and xylem parenchyma. It is unfortunate that no parenchymatous cells are preserved (except a few in the medulla), for one is therefore unable to follow the complete course of differentiation of the anomalous xylem. It is seen (*cf*. Pl. III, fig. 13) that the two sides of the crack were originally together; absolute correspondence cannot be expected, as the thin-walled xylem cells are, of course, not represented.

It is clear that the specimen consists of a complete cylinder of secondary wood, the zones of which are interrupted only where the

* Barber, 1898. † Walton, 1923, p. 87. ‡ *Ibid.*, pp. 87 and 98.

strands pass out to the appendages. These interruptions, which are extended in vertical radial planes, have probably been considerably augmented, and probably, as in the other species of *Rhexoxylon*, will be further augmented by the secondary growths found in them. If this process were continued indefinitely, the result would be the separation of the woody cylinder into distinct and widely separated sectors, such as are found in *R. tetrapteridoides* and *R. africanum*. There are various strands passing out radially in the cracks associated with the traces. The larger ones are probably the traces themselves (cf. *R. tetrapteridoides*, Wal.).* It is impossible to say whether there is one trace present or more, as several distinct strands are seen in the transverse section of the stem. There may be different portions of the same strand cut at different distances from the centre.† In addition to these traces (?), which are cut more or less lengthwise, there are other smaller ones which are cut crosswise, and which are almost certainly homologous with the strands in the tangential cracks.

In tangential section these suggestions are confirmed. The trace system appears to be complicated by a large amount of secondary growth, and resembles "the torn and imperfectly preserved trace" ‡ in the Antarctic specimen ‡ very closely in the occasional separation of the accompanying secondary xylem into two main divergent wedges. More detail can be made out in the South African specimen, and it appears that the trace, if it is not indeed the vascular supply to something other than a leaf, is more or less mesarch in structure. There is a central strand of very small tracheidal elements surrounded by a radiating arrangement of larger ones. On the upper and under side the development of secondary xylem attains its maximum development. There are indications of stone cells, or secretory cells, associated with the trace.

The pith is poorly preserved. In transverse section various structures are evident. A large part of the pith in one section consists of an irregular, transparent, colourless region, in which there are remains of large cells, some of which have dark inclusions. The rest of the pith is occupied by a transparent amber-coloured material, in which portions of the tissues are also preserved to a certain extent. Amber-coloured matrix of a lighter tint permeates the entire secondary wood of the stem, and is continuous with the darker matrix which occupies the spaces in the pith. In longitudinal section the pith appears at first sight to be discoid: this appearance is due to large groups of cells in

* Walton, 1923, p. 84, pl. v, fig. 1. † Seward, 1914, p. 21.

‡ *Ibid.*, p. 22, pl. vii, fig. 42.

the clear matrix alternating with spaces occupied mainly with the clear, deep, amber-coloured matrix. These discs of cells are of variable breadth, not always spanning the pith. In some places their constituent cells are preserved, and it is clear that they are of the nature of stone cells, the thick walls of which are abundantly pitted; they often exhibit a different stage of preservation, in which there is a dark reticulum with small projections on the surface. These discs are, therefore, composed of stone cells, and correspond to the patches of "secretory sacs" in the Antarctic specimen, and are similar to the structures in *Rhexoxylon tetrăpteridoides*, Wal.,* termed "sclerotic nests." In *Rhexoxylon priestleyi* they are, as we see, larger in relation to the pith than in the former species. In addition to these sclerotic nests there are other structures composed of smaller cells, usually permeated with the darker matrix, which can, I think, be nothing else than secretory reservoirs or ducts similar to those figured in *R. tetrapteridoides*.* Some strands of spiral or reticulate xylem similar to those found in the cracks occur in the pith, running in a transverse direction parallel to the discs of sclereids. These are, without doubt, homologous with the system of small strands in the other species of *Rhexoxylon*. I am inclined to believe that *Pityosporites antarcticus* is a crushed or irregular-shaped stone cell in the state of preservation common in this South African specimen, in which the pitted nature of the thick wall is represented by a reticulation in the carbonaceous remains of the wall. The two-lobed shape of *P. antarcticus* has not been seen in the new specimen, but many structures which might have been interpreted as simple reticulately ornamented microspores are present, were it not that their relation to definite stone cells is revealed unmistakably.

The perimedullary region, which is fortunately well preserved, has a ring of centripetally developed xylem of a definitely secondary character (Pl. II, fig. 11). The elements of which this ring is built vary in size, and it is not clear whether the main bulk of this secondary tissue has been developed in connection with primary xylem groups or not. In the centre of fig. 11, Pl. II, the tracheids in the centripetal ring are larger on the side next to the protoxylems of the centrifugal secondary wood. These larger tracheids might conceivably represent primary tissue; on the other hand, there is a continuous series of secondary tracheids in series with the larger ones.

On either side of this central group (Pl. II, fig. 11) there seems to be definite indication of the separation of some vascular supply

* Walton, 1923, text-fig. iv, 3, and pl. v, fig. 7.

to an appendage. The protoxylems of the centrifugal secondary wood are placed further out in relation to the central axis, and the bays formed in this way are filled with the centripetal xylem of the perimedullary ring.

There seems to be definite evidence here that the centripetal ring is of an "anomalous" character, and is in fact a "tertiary" intercalation. It will be noticed that lying internally to the centripetal ring at *a*, fig. 11, Pl. II, are two small strands of apparently centrifugally seriated tracheids, one of them three tracheids broad tangentially, and the other two. It will be noticed also on passing from these two groups across the ring of centripetal xylem, as nearly as possible along a line of seriation to the normal centrifugal wood, that these two little groups would have fitted very perfectly on to the end of two files of tracheids, one three and the other two wide, which appear to be truncated in shape in comparison with the groups of protoxylems elsewhere.

The secondary wood consists of tracheids, uniseriate medullary rays, and the parenchyma to which reference has already been made. The tracheids are pitted exclusively, as far as one can judge, on the radial walls. The pits are arranged in one to two series, and were probably in contact; when in two series they usually alternate (Pl. III, fig. 14). The pitting in the "field" consists of from four to seven small pits. The rays are low, being from 1 to 8 cells high. This corresponds closely with the description of the Antarctic specimen.*

The discovery of this better-preserved specimen clears up to a certain extent some of the rather doubtful points in my previous account of *Rhexoxylon*. It is clear now that in *R. priestleyi*, Sew., the stem possessed a complete cylinder of secondary wood, interrupted where the vascular supply passes out to some appendage, but consisting in all probability of entirely centrifugally differentiated elements. Internal to this normal ring there has been a later development of anomalous wood in the perimedullary region or in close association with the protoxylems of the normal ring. Apart from the anomalous growth, the structure of the vascular system is not unlike that of *D. pedroi*, Zeiller,† for which the generic name *Trigonomyelon* is proposed, as it shows sufficiently distinct characters to differentiate it clearly from the Dadoxylon form-group. White ‡ also has questioned its attribution to *Dadoxylon*. *Trigonomyelon pedroi*, Zeill. sp., has three projections of the pith, each representing

* Seward, *ibid.*, p. 20. † Zeiller, 1895. ‡ White, 1908.

the positions of departure of the leaf system. These bays are probably homologous with those of *Rhexoxylon priestleyi* (Pl. II, fig. 11, *tt*). *Trigonomyelon* also possesses secondary wood of much the same general character as *Rhexoxylon*.*

The occurrence of *Rhexoxylon priestleyi*, Sew., in South Africa is of considerable interest. *Rhexoxylon* is a genus of plants with a very exceptional type of vascular system. The only other plants which show any comparable arrangement of the tissues are the *Medulloseae* and the living Lianes (Angiosperms and one genus of Gymnosperms, *Gnetum*). I have already shown † that in all probability *Rhexoxylon* is not related to the *Medulloseae* but more probably to the Gymnospermous plexus, to which the Southern Hemisphere Dadoxyla belonged, possibly Cordaitean or Araucarian. However that may be, it seems likely that this anomalous vascular arrangement was a physiological adaptation to rather special conditions—conditions probably *not* of world-wide incidence. It is thus particularly striking, as the present-day climatic conditions over South Africa and South Victoria Land are so different. A Glossopteris Flora is now known to have existed, preceded by a glacial phase,‡ in South Africa and Antarctica. Above this lie considerable developments of sediments, in South Africa the Upper Karroo Beds and in South Victoria Land the Beacon Sandstone Series, from the upper part of which *Rhexoxylon priestleyi*, Sew. sp., was probably derived. This suggests that the Triassic is represented in a part of the Upper Beacon Sandstone, as *Rhexoxylon*, judging from its distribution in South Africa, is of Triassic age.§

Dadoxylon sclerosum, sp. nov. (Albany Museum, 619). Pl. II, figs. 7–10. (See footnote, p. 22.)

The type specimen consists of a block of silicified stem with the pith in an eccentric position. Assuming that the pith was in the centre of the stem, the latter must have had a diameter of 16 cms. at least. In one transverse section twelve distinct growth rings are present of the type common in stems, *i.e.* with a broad zone of the late type of element into which the preceding early type of wood gradually merges. The breadth of a ring varies from 3 to 12 mm. (av. 5·5). The wood consists of radially seriated tracheids and medullary rays which are almost invariably uniseriate. Wound parenchyma is present in one or two places, but no normal xylem parenchyma can

* Walton, 1923, p. 104.

† *Ibid.*, p. 105.

‡ Du Toit, A. L., 1921, p. 221.

§ Walton, J., *loc. cit.*, p. 81.

be detected. The pith, which is poorly preserved and somewhat distorted, consists of large parenchymatous cells, but in the peripheral part of the pith there are small groups of about a dozen thick-walled cells (Pl. II, fig. 9). Unfortunately, only one longitudinal section passing tangentially through the pith was obtainable in this section (Pl. II, fig. 8), which cuts two of these groups of thick-walled elements ; it is clear that they form, as far as the section shows, continuous vertical columns, and are individually of the nature of sclereids. In transverse section these groups of sclereids, whenever they can be distinguished clearly, are almost always opposite and close to the apices of the wedges of xylem which project into the pith. The smallest distinguishable tracheids lie at the ends of these xylem wedges ; it is therefore almost certain that the xylem is entirely centrifugal. Several separate leaf traces, which appear to be single in construction, can be seen leaving the centre of the stem. Flanking the wedges of xylem and separating them from the pith is a narrow zone, one or two cells thick, of cells which are comparatively thin-walled and much elongated vertically ; one was seen to be at least ten times as long as broad (Pl. II, fig. 8, *l*). The tangential diameter of the larger tracheids is about 50μ ; the radial diameter about 50μ in the early wood, and as small as 17μ in the late wood. In the early elements of the growth rings the pitting on the radial walls consists of one or two series of pits which are usually in contact and slightly flattened (Pl. II, fig. 10), but they often appear quite circular. When the pits are in two series those of one series may be closely packed against and alternate with the members of the other series, or the two series may be separated by a space about 3 or 4μ wide of unpitted wall. Oppositely placed pits are very rare, if present at all. Considerable lengths of tracheid wall without pits are found, but definite series of separate pits, such as occur in *D. arberi*, Sew., seem to be almost completely absent ; the pits in *Dadoxylon sclerosum* seem to be rarely separate. The pits when circular are 17μ in diameter, when flattened they measure $13\mu \times 17\mu$. In tangential sections of the wood the tracheids are seen to have their tangential walls unpitted.

The rays are almost invariably uniseriate and from 1 to 33 cells high. The individual cells of the rays are somewhat variable in size, the vertical height being from 17μ to 35μ, the tangential width 22μ, and the length radially 140μ to 170μ. One peculiar, though inconstant, feature of this wood is the presence of some medullary rays of exceptionally large cells, the height of the individual cells being 40–60μ, the tangential width 26μ, and the length 130μ.

The pitting in the field is not well preserved, but in one or two places where the material is dark in colour the pits can be made out quite definitely. The pitting in the field is very similar to that in *D. arberi*, only the pits, which are simple and slightly elliptical, tend to be rather fewer in number, typically one to four. Their dimensions are approximately $6\mu \times 8\mu$.

Fungal hyphae are present in some parts of the wood. An example was seen in which one of these hyphae passed unbroken through a series of over thirty tracheids in a direction parallel to the medullary rays. They can also be seen traversing the tracheids in a tangential direction. Some of the tracheids appear to have "resinous" inclusions.

Locality.—"Modderpoort, Stormberg," Cape Province (Mr. P. Fletcher).

Horizon.—"Top of Molteno Beds or possibly higher."

Cf. *Dadoxylon sclerosum*, sp. nov. (2954 S.A. Mus.).

A sample of secondary wood from Kromme Spruit, Herschel, exhibits characters which are indistinguishable from those of *D. sclerosum* in dimensions as well as in other respects. The preservation is not quite so good. There also occur in this specimen examples of the abnormally large ray cells, a character which I have not observed so far in other fossil woods.

Locality.—Kromme Spruit, Herschel, Cape Province.

Horizon.—"Base of Red Beds, Stormberg Series."

Note.—Another specimen of secondary wood * which is of interest in this connection is one from Intombi Camp, Ladysmith, from "Ecca Shales." It resembles *Dadoxylon sclerosum* in the character of the pitting. In places, however, there is definite spiral thickening (see p. 20) in the tracheids, along with the usual bordered pits.

Arber describes this specimen briefly in the Annals of the Natal Museum, vol. ii, pt. 2, 1910, as *Dadoxylon* sp.

Dadoxylon sp.

This specimen from the "Base of the Ecca or Upper Dwyka Shales" exhibits some interesting features in spite of being poorly preserved. The external form suggests that of a curved branch or root. The fossil is easily broken and crumbles easily. It splits most readily

* British Museum Collection Slides, 12637–8–9.

along the radial longitudinal planes in the wood, exhibiting the grain of the wood on the fractured surfaces. It also breaks along cylindrical surfaces which are approximately coincident with the surfaces of the late wood of the growth rings. The pith is not preserved.

In one incomplete transverse section cut from the specimen, one can detect on careful examination the presence of two of the rings of late wood ; each is followed abruptly by large early-wood elements. The change from early to late wood is gradual, and the tracheids of the late wood may measure as little as 16μ, and those of the early wood as much as 50μ (av. 45μ) in radial diameter. The growth rings are 2 mm., 10 mm., 13 mm., and 13 mm. broad respectively, the 2-mm. ring being next to the pith. The tracheids are square to rectangular, and are in very regular radial files, separated by not very frequent rays. In radial section it is evident from the frequency with which the sharply tapered ends of tracheids occur that the tracheids are rather shorter than in most gymnospermous woods.* The medullary rays are somewhat few in number, and are seen to be from 1 to 8 cells high. In tangential section they are seen to be uniseriate. In sections cut from this specimen none of the finer structures can be made out, as the walls of the cells are covered with a granular crystalline deposit. It is possible, however, to get a good idea of the radial structure of the cell walls by examination of the fractured surfaces.

The radial walls of the tracheids have numerous bordered pits arranged in one to three series ; these pits were contiguous and probably slightly flattened. I have not seen areas of tracheid wall without pits. The diameter of the pits is approximately 10μ, which is the average of measurements from several contiguous series of pits. The tracheids are often seen with their tapering ends curved in the radial plane so that the terminal portion of each is in contact with several tracheids in the adjacent files (cf. *D. arberi*, Sew., Arber, 1905, text-fig. 42). In *Rhexoxylon africanum*, the secondary wood of which was examined in radial fracture, the tracheids are not curved at their ends to such an extent.†

Specimen. Cat. No. 2946 S.A. Mus.

Locality.—Near Noro Kei Pan, Gordonia (Bechuanaland, Cape Province).

Horizon.—Base of Ecca or Upper Dwyka Shales (Lower Permian).

* Arber, 1905. *Cf.* "Dadoxylon australe," Arber, p. 192, and text-fig. 42.

Phyllocladoxylon capense, sp. nov.
(Pl. III, figs. 17, 18.)

The specimen (No. 1950, Albany Museum), of which only three sections were available for examination by the writer, consists of secondary wood only. It is riddled with borings which run in a longitudinal direction in the wood. Distinct growth rings are present, and are of the stem-wood type. The rings are clearly composite (Pl. III, fig. 17). In transverse section the medullary rays are seen to be uniseriate, and no wood parenchyma is evident. The rays cells are represented by a black substance in the lumen of the original cells, the walls of which have generally disappeared.

In longitudinal section structures, which must be interpreted as resin plates, can be seen in the tracheids. No septate tracheids or wood parenchyma is represented in any of the sections. The tracheids are pitted on the radial walls, only occasionally can a small bordered pit be found on the tangential wall of a late formed element of a ring. The bordered pits are elliptical, with the major axis of the ellipse at right angles to the long axis of the tracheid. They may be arranged widely separated in single file or may be contiguous. A biseriate arrangement is also a regular feature of this wood, and then the pits may be either opposite or alternate, but not usually flattened by contact. In the wider spring elements the pits are usually about $14\mu \times 20\mu$, while in the late wood, and even in the early wood, they may be approximately circular and 9μ in diameter. This variability in the size of the tracheid pits is one of the distinctive characteristics of this wood. The breadths of the tracheids seen in transverse section are about 35μ (max. 45μ) radially and 50μ tangentially in the early wood, and in the late wood may be as little as 20μ radially.

The medullary rays are uniseriate and vary from 1 to 18 cells in height, that of a single cell being from 22μ to 25μ. In radial section the field pitting is seen to consist of a large simple pit filling the field almost completely (Pl. III, fig. 18). The walls of the ray cells are not preserved, and must have been considerably thinner than those of the tracheids. The large pit seen in the field is the pit in the wall of the tracheid; and this is confirmed by comparison with what is seen in tangential section. The pit in the field is usually elliptical with the long axis horizontal. The axis length in a large pit may be as much as 40μ, the vertical axis being 13μ. In the late wood the corresponding pit dimensions may be $17\mu \times 9\mu$. The absence of a

border is probably an original feature. Fungus mycelium is present in some parts of the wood.

I have used the generic form name, *Phyllocladoxylon*, Gothan, although objections to its use have been raised because of the difficulty of distinguishing between *Podocarpoxylon* and *Phyllocladoxylon*.* The field pitting in some members of the *Podocarpoxylon* group is variable; the same wood having in some parts of the rays bordered pits in the field, and at others simple pits. There is no indication of variability in this species, and although the name *Phyllocladoxylon* may be said to be rather misleading, the description originally given with the name is quite clear.† This species differs from woods included in Xenoxylon in having much smaller pits in the tracheids.

This specimen is unlike previously described *Phyllocladoxyla* in the size of its field pitting. The specific name *capense* is proposed for fossil wood possessing the characters enumerated above. It is the first of its form-genus to be found in South Africa.

Horizon.—Unknown (Cretaceous or Tertiary ?).

Locality.—Sunday River, Cape (Dr. Atherstone).

Spiroxylon Africanum, sp. et gen. nov.

(Pl. II, fig. 12, and Pl. III, figs. 15, 16.)

An interesting specimen (No. 2945, S.A. Mus.) from the neighbourhood of Arms Fontein, of unknown horizon, exhibits a type of secondary wood structure very similar in some respects to that of the *Taxoideae*, Pilger.‡ The preservation is good, but unfortunately only the secondary wood is represented.

In transverse section growth zones are clearly distinguishable, but on examination under the microscope these are seen to be rather ill-defined. There is no sharp change in dimensions from the tracheids of the summer-formed wood to those of the succeeding spring wood. The average breadth of a growth zone is about 7 mm. The diameters of the tracheids, radial and tangential, are, for the spring wood, $33\mu \times 26\mu$, and for the summer wood, $26\mu \times 24\mu$ respectively. In tangential section the medullary rays are seen to be almost entirely uniseriate and to vary from 1 to 18 cells in height. The tracheids in all longitudinal sections are seen to have spiral thickening bands

* Seward, 1919, p. 203. † Gothan, 1905, p. 47, fig. 8*d*.

‡ Pilger, 1903. Groups Taxus, Cephalotaxus, and Torreya in the Taxoideae.

(Spiralverdickung *) in addition to the normal secondary wall thickening. These bands in size bear the same relation to the tracheid as do those in the living genus Taxus. There may be one or two of these bands present, and in the latter arrangement a change to the single condition may be effected by a concurrence of the bands. Bordered pits have not been observed in the tangential walls of the tracheids. In radial section the rays, as can also be observed in tangential section, are composed of comparatively thin-walled cells. The dimensions of the average ray cell are 31μ and 180μ vertically and radially respectively. Occasionally the radial measurement may reach 220μ. There are two to eight small pits in the field. No border can be seen to the pits, though it is possible that a border may have been present. Pits have not been observed on the other walls of the medullary ray cells. The pitting in the tracheids consists of a single series of bordered pits (diameter 13 approx.) in contact and slightly compressed vertically. Occasionally the pits are in two series, when they usually alternate, though instances have been observed in which they are opposite. Some pits are seen to contain a dark central structure which may represent a torus.

The spiral bands pass over the wall between the pits, and do not, as far as can be seen, pass across the border in any example. This presence of bands crossing over the surface of the wall between pits makes it impossible to be certain whether Sanio's rims are present in the primary wall or not.

No resin canals or wood parenchyma have been observed in any of the sections of this specimen.

Comparison with other Fossil Woods.

The presence of spiral thickenings in the tracheids at once limits the number of fossil woods with which this specimen can be compared. According to Gothan † and Seward ‡ many of the fossils which have been described as possessing spiral bands in the tracheids are in a state of preservation in which partial disorganisation has caused the fibrillar structure of the cell's wall, normally invisible, to become evident. Thus the spiral thickenings in *Taxoxylon Philpii*, Shirley,§ are certainly due to disorganisation, as the sections figured show unmistakably. *Taxoxylon scalariforme*, Goepp. sp., is one of

* Gothan, 1905, p. 54.

† *Ibid.*, pp. 96–97.

‡ Seward, 1919, pp. 202–203.

§ Shirley, 1902, p. 15, pls. x and xi.

the fossils which probably has true spiral-thickening bands in addition to bordered pitting in the secondary wood. Gothan * states definitely that *Taxoxylon scalariforme*, Goepp. sp., stands as the earliest fossil record of the Taxalean type of spiral thickening. It differs mainly from the South African specimen in having the pits in the tracheids distant instead of in contact. *Taxoxylon scalariforme*, Goepp. sp., is of Tertiary Age.

Among the collection of fossil woods in the British Museum is a specimen (*Dadoxylon* sp., sections 12637–8–9) of what may be termed a *Dadoxylon* with quite unmistakable spiral thickening, in addition to the normal secondary wall thickening with bordered pits, in certain zones of the wood. The specimen is stated to come from the Ecca Shales, Intombi Camp, Ladysmith.

The Taxoideae, Pilger,† are the only gymnospermous group of genera which has similar spiral thickening as a constant feature of the secondary wood tracheids. Among the Coniferae, however, spiral thickening in the secondary wood is occasionally found. Thus Gothan,‡ Bailey,§ and others || have mentioned the presence of these structures in the Abietineae, and in other groups. Spiral thickening is a constant feature in *Pseudotsuga*, and is usually present in the late wood of the first few years' growth of *Picea* and *Larix*.|| These three genera have, however, Abietinean pitting.

The nature of the "spiral-thickening bands" is not the same in the three genera of the *Taxoideae*; in *Taxus*, to which the fossil shows the closest parallel in this respect, the bands are in the form of spirals which are usually confined to the wall between the pits, but may occasionally pass across the border; in *Cephalotaxus* the bands may be placed so far over the border of the pits that they become tangential to the margin of the pore; and in *Torreya* sp., in some sections examined the arrangement is even more complicated, for the bands are sometimes in pairs, and one member of the pair may be thinner than the other, and may terminate at the margin of the pore. The main points of difference are most conveniently shown in tabulation.

* Gothan, 1905, p. 97.

† Pilger, 1903. Taxaceae: das Pflanzenreich.

‡ Gothan, 1905, pp. 61–62.

§ Bailey, 1909, p. 54.

|| Jones, 1912.

	Spiroxylon, gen. nov.	*Taxus.*	*Cephalotaxus.*	*Torreya.*
Average vert. diam. of ray cells	31μ	19μ	..	21μ
Pits in field . .	2 to 8	1 to 4	2 to 4	1 to 5
Diam. of bordered pits	11 ,, 13μ	13 ,, 17μ	13 μ	13 ,, 15μ
Arrangement of pits in tracheids	Alternating (occ. opposite). In contact.	Opposite. Distant.	Opposite. Distant.	Opposite. Distant.

Thus the main differences between the fossil and the living plants included in the *Taxoideae* are : First, the alternating arrangement of the pits when more than one series is present in the tracheids ; second, the size of the pits and their somewhat compressed form ; and third, the larger number of pits in the field.

Gothan shows that spiral thickening (spiralverdickung), such as is characteristic of the *Taxoideae*, *Pseudotsuga*, *Tsuga*, and *Larix*, and is found in *Taxoxylon scalariforme*, Goepp. sp., and in our fossil, must be carefully distinguished from spiral striation (spiralstreifung), such as occurs in partially disorganised wood and in a certain number of woods, fossil and living.*

These differences are of interest as furnishing additional though somewhat slender evidence in favour of a possibly Cordaitean ancestry for the Taxoideae. The structure of the seeds and cones of the Taxoideae has led various investigators to regard the Taxoideae as direct descendants of the Cordaitales. Worsdell † came to the conclusion that *Cephalotaxus* has a primitive type of seed that suggests affinities with the Cycadales. Oliver ‡ has recognised primitive features in *Torreya*. Sahni,§ finally in an account of a reinvestigation of the seed of *Taxus*, shows in a convincing fashion that the structures of the seeds in the Taxoideae are most easily understood by considering them to be derived from some Palaeozoic seed-types, some of which are undoubtedly Cordaitean, concluding that the " Taxales " are of Cordaitean origin. In a subsequent paper || he calls attention to the presence of sterile bracts in the male cone of *Cephalotaxus*, and suggests a comparison between the cone of the latter and the male inflorescence of *Cordaites*.

The name *Spiroxylon africanum* is suggested for this fossil wood

* Gothan, 1905, pp. 67–87. † Worsdell, 1900.
‡ Oliver, 1903. § Sahni, B. (1920, A). || *Ibid.*, (1920, B).

in which the tracheids have spiral thickening in addition to the bordered pits. The pits are small and are characteristically in compressed series when uniseriate, and normally alternate when in two series, characters which are Araucarian in character as opposed to the pitting in the living *Taxus* and in the fossil *Taxoxylon scalariforme* (Goepp.),* in both of which types the pitting is Abietinean.

Locality.—Arms Fontein. (This is probably an error in the Museum Catalogue, and should be Harmsfontein, which is the old name of what is now the Carnarvon Commonage.)

Horizon.—Unknown.

Note.—There is little reliable evidence as to age to be derived from a study of the structure of this sample of secondary wood, but from general considerations it suggests a possible derivation from strata of not earlier than Mesozoic, and quite possibly of Tertiary Age. Shirley † accepts Renault's record of *Taxoxylon* in the Carboniferous, and suggests that *Taxoxylon Philpii*, Shir., helps to bridge the palaeontological gap between that era and the Tertiary. Gothan and others agree in maintaining that *T. scalariforme* is the only fossil wood of the Taxus type. As *T. Philpii*, Shir., is in a state of disorganisation frequently found in fossil and sub-fossil wood, it cannot be accepted as belonging to *Taxoxylon*, Unger, nor have we yet any unequivocal record of any Taxoidean wood earlier than the Tertiary.

* Seward, 1919, p. 202. † Shirley, 1902.

NOTE.—*Since the above account was written my attention has been drawn to the description of* Dadoxylon scleroticum (*Gothan : Zeitschr. Deutsch. Geol. Ges.*, 60, 1908, *Monatsberichte, s.* 22–25), *with which* D. sclerosum *is not to be confused. Certain peculiarities of the former suggest a possible relationship to the genus* Rhexoxylon.

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DESCRIPTION OF FIGURES.

Plate I.

Dadoxylon arberi, Seward.

FIG.

1. Transverse section of secondary wood. *a*, incomplete ring of late type of tracheids, see text. × 2·2.
2. Radial section of perimedullary region. On left badly preserved pith parenchyma with remains of protoxylem elements in a stretched and distorted condition. From the centre to the right transition region between protoxylem and secondary wood. × 220.
3. Radial section of later-formed secondary wood. × 120.
4. Radial section through perimedullary region. To left of centre secretory element with black inclusion. × 62.
5. Radial section of secondary wood to illustrate the nature of the pitting in the field of the tracheids and ray cells. × 350.
6. Tangential section of secondary wood. Note presence of biseriate ray seen towards the bottom left-hand corner. × 66.

Plate II.

Dadoxylon sclerosum, sp. nov.

7. Transverse section of secondary wood near to and including part of the medullary region. *p.x.* position of some of the protoxylems (shown at increased magnification in fig. 9). × 2·2.
8. Tangential section through the periphery of the pith. *l*, portion of sheath of thin-walled cells which flanks the wedges of xylem projecting into the pith. *px.* protoxylem of one of these wedges. *sc*, *sc*, columns of thick-walled sclerous elements, one of which is seen cut transversely at *sc*, in fig. 9. (The roundish black bodies and the circular structure near *px* are probably of animal origin.) × 62.
9. Enlarged portion of fig. 7 at *px*. Portions of five primary xylem strands with accompanying secondary wood can be seen; one of them, *t*, is passing out to some lateral appendage. *sc*, group of sclerous cells. × 62.
10. Radial section of secondary wood to illustrate the characteristics of the tracheid pitting. × 120.

Rhexoxylon priestleyi, Seward sp.

11. Transverse section through perimedullary region. The normal (centrifugal) secondary wood of tracheids with large lumena is seen towards the top of the figure. The protoxylems can be seen in the centre. Below the centre lies the centripetally differentiated anomalous xylem, the tracheids of which have smaller lumena and appear to be somewhat crushed. *tt*, positions of outgoing strands. *ax*, anomalous xylem. *a*, small group of disrupted normal secondary xylem elements. *sc*, group of stone cells. *p*, pith cavity. × 62.

Spiroxylon africanum, gen. et sp. nov.

12. Transverse section of secondary wood. × 2·2.

Plate III.

Rhexoxylon priestleyi, Seward sp.

FIG.

13. Transverse section secondary wood exhibiting tangential crack filled with anomalous secondary growth. *r*, late-formed elements of a growth ring. *y*, space originally occupied by a thin-walled cell. The regular seriation of the surrounding tracheids is disturbed at this point. × 62.
14. Radial section of secondary wood. × 120.

Spiroxylon africanum, gen. et sp. nov.

15. Tangential section of secondary wood. Note occasional occurrence of biseriate rays. × 66.
16. Radial section of secondary wood to illustrate the nature of the tracheid pitting. × 120.

Phyllocladoxylon capense, sp. nov.

17. Transverse section of secondary wood exhibiting bore-holes of animal origin. The centre of the stem is above the portion represented in the figure. × 2·2.
18. Radial section of secondary wood to illustrate the nature of the tracheid pitting. × 120.

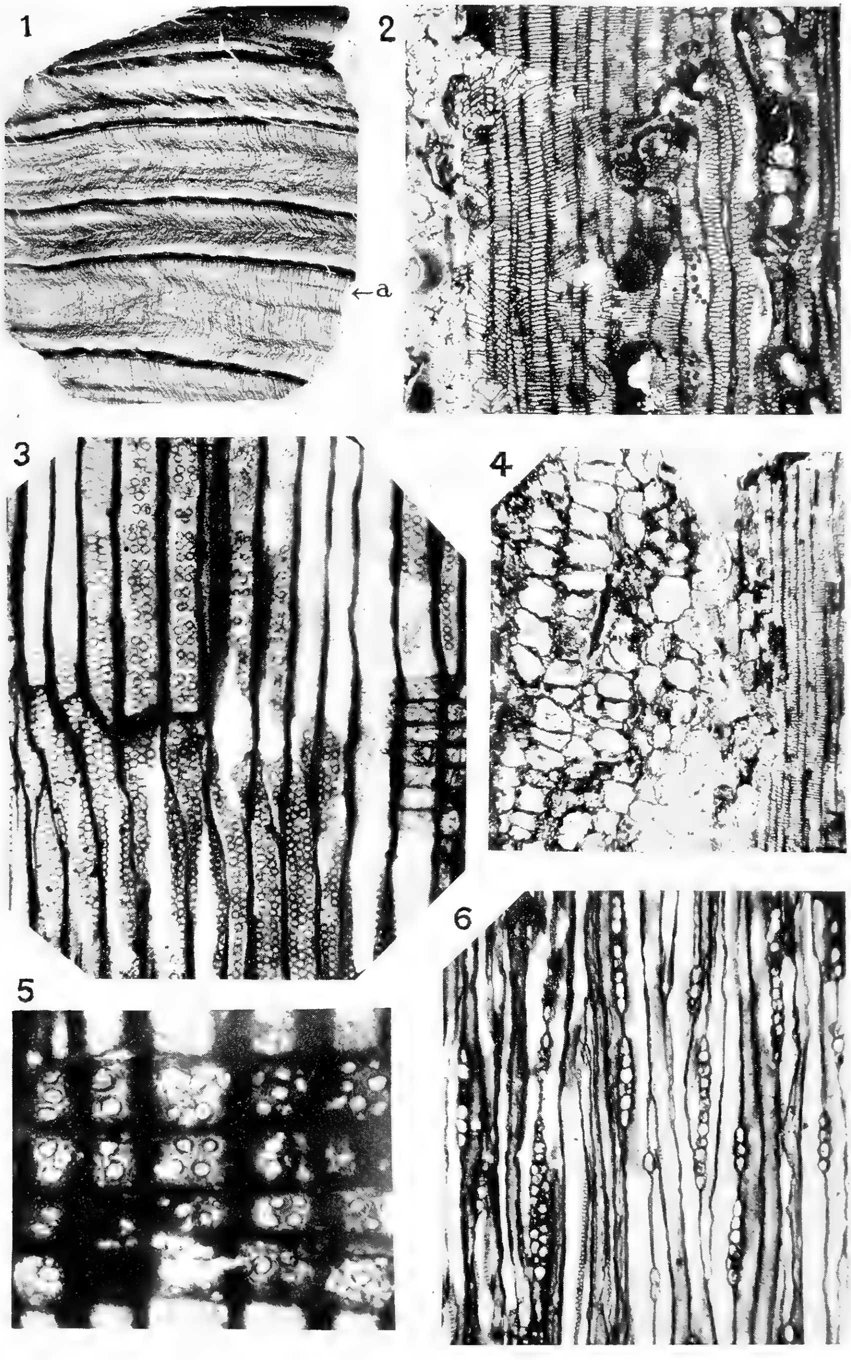

Photo. J. W.

DADOXYLON ARBERI, SEWARD.

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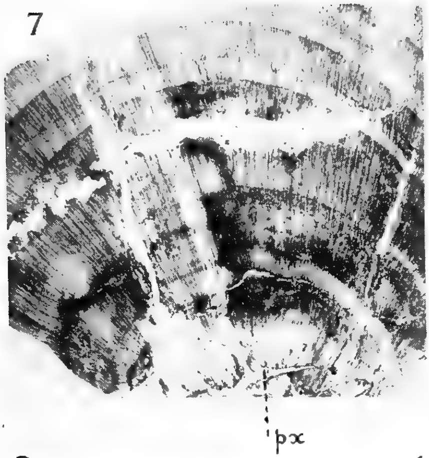
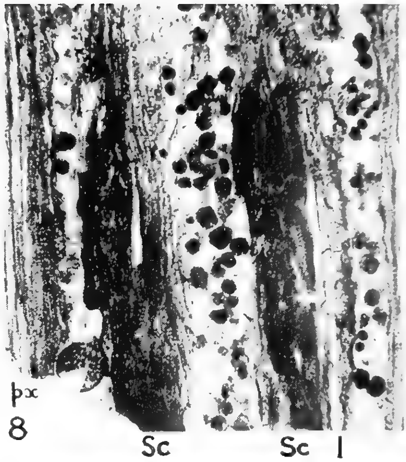
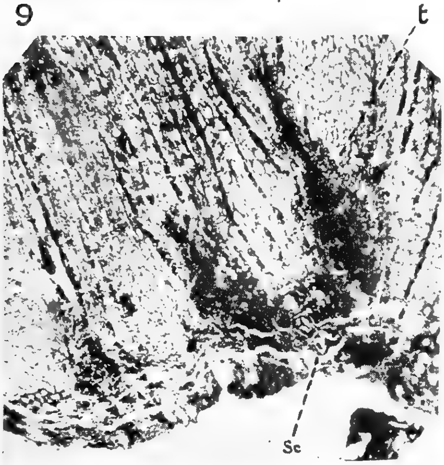


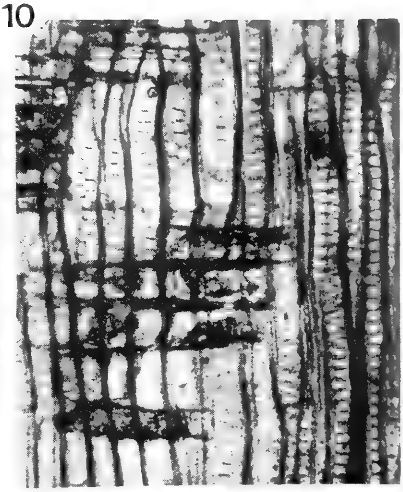
8



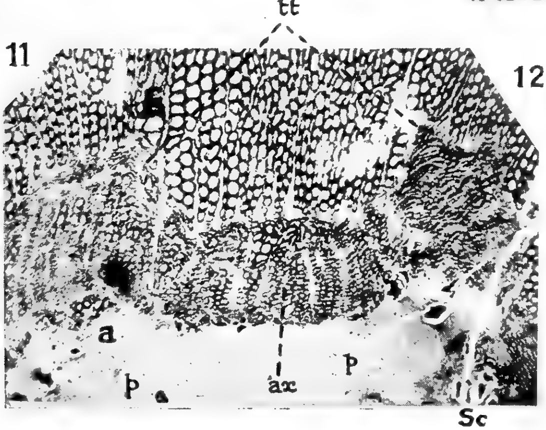
9



10



11



12

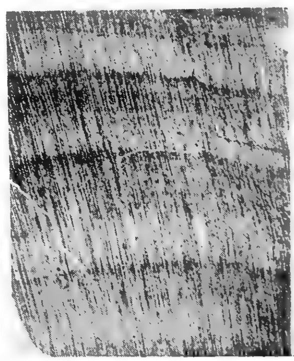


Photo. J. W.

7–10. Dadoxylon sclerosum. 11. Rhexoxylon priestleyi.
12. Spiroxylon africanum.

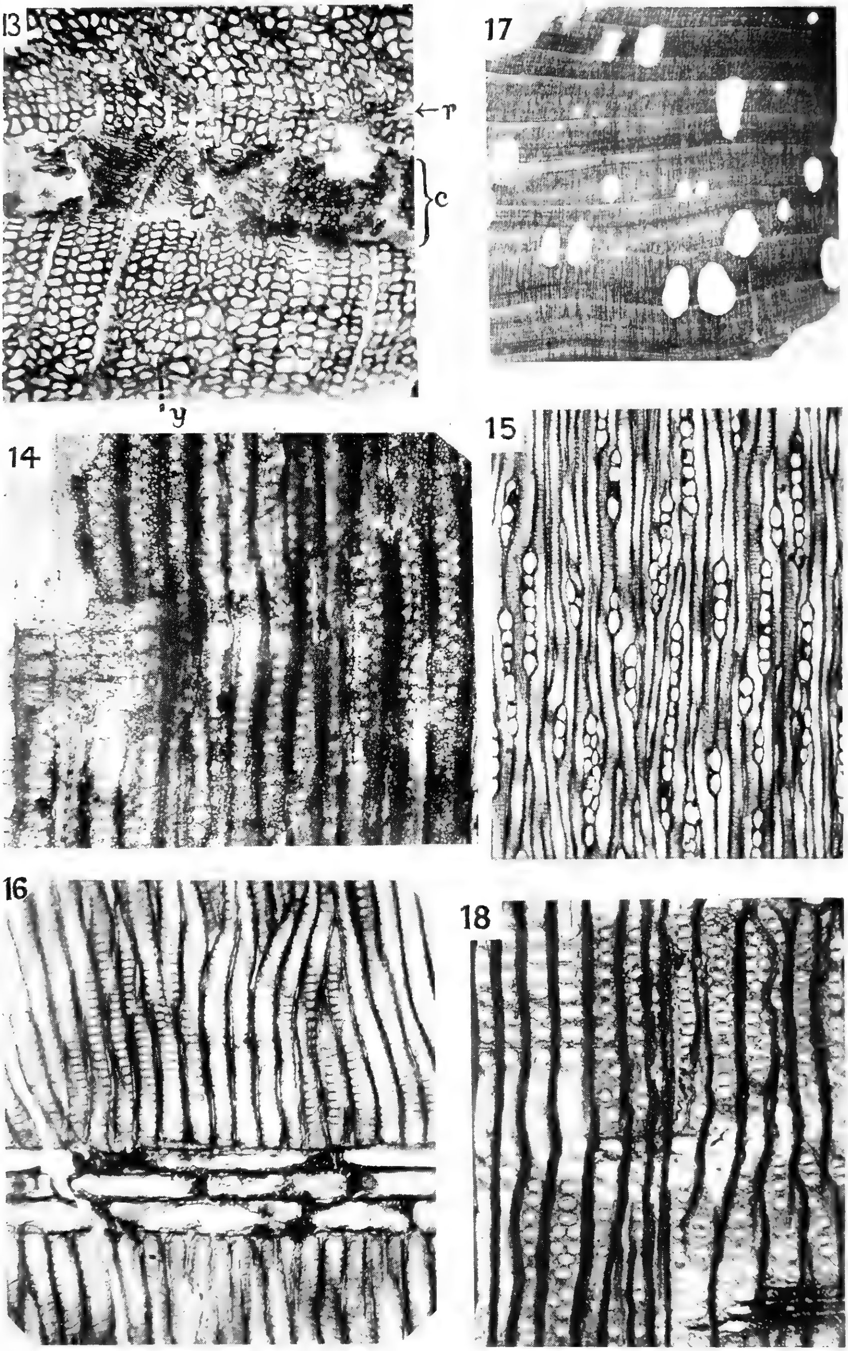


Photo. J. W.

13, 14. Rhexoxylon priestleyi. 15. 16. Spiroxylon africanum.
17, 18. Phyllocladoxylon capense.

2. *Revision of the Fauna of the Bokkeveld Beds.*—By F. R. Cowper Reed, M.A., Sc.D., F.G.S.

(With Plates IV–XI.)

Introduction.

Since the publication of the descriptions of the Trilobita, Brachiopoda, and Mollusca of the Bokkeveld Beds by Mr. P. Lake * and the author † in the Annals of the South African Museum about twenty years ago, a considerable amount of fresh material has been collected. Some of it was described by the author ‡ in a supplementary paper in the Annals in 1908, and in another communication to the Geological Magazine in 1906,§ while in the latter year Professor Schwarz || dealt with some specimens in the Albany Museum and described several new species. The present author reviewed the whole fauna and its relations in 1907,¶ and gave a list of references to papers concerning it up to that date. The great progress which has been made during recent years in our knowledge of the Devonian faunas of the South American continent has led to their closer comparison with the fossils of the Bokkeveld Beds, and Thomas,** Knod,†† Clarke,‡‡ and

* Lake, "The Trilobites of the Bokkeveld Beds," Ann. S. Afr. Mus., vol. iv, pt. 4, No. 9, 1904, pp. 201–220, pls. xxiv–xxviii.

† Reed, "Brachiopoda from the Bokkeveld Beds," *ibid.*, vol. iv, pt. 3, No. 7, 1903, pp. 165–200, pls. xx–xxiii; "Mollusca from the Bokkeveld Beds," *ibid.*, vol. iv, pt. 6, No. 11, 1904, pp. 239–272, pls. xxx–xxxii.

‡ Reed, "New Fossils from the Bokkeveld Beds," *ibid.*, vol. iv, pt. 8, No. 14, pp. 381–406, pls. xlvii, xlviii.

§ Reed, "New Fossils from the Bokkeveld Beds," Geol. Mag., Dec. v, vol. iii, 1906, pp. 301–310, pls. xvi, xvii.

|| Schwarz, "South African Palaeozoic Fossils," Rec. Alb. Mus., vol. i, pt. 6, 1906, pp. 347–404, pls. vi–x; Reed, Geol. Mag., Dec. v, vol. iv, 1907, pp. 34–36.

¶ Reed, "Fauna of the Bokkeveld Beds," Geol. Mag., Dec. v, vol. iv, pp. 166–171, 222–232.

** Thomas, Zeitschr. deut. geol. Gesell., vol. lvii, 1905, pp. 233–290, pls. xi–xiv.

†† Knod, Neues Jahrb. f. Miner. Geol., Beil. Bd. xxv, 1908, pp. 493–600, pls. xxi–xxxi.

‡‡ Clarke, "Fosseis devonianos do Parana," Mon. Serv. Geol. Miner. Brasil, vol. i, 1913, pp. 1–353, pls. i–xxvii.

Kozlowski * have paid special attention to this matter, while further material from the Falkland Isles has been studied by Newton † and Clarke. It seemed, therefore, to the author that a revision of the South African material was desirable as well as an examination of the large number of new specimens which had been added to various museums. Accordingly, during a visit in 1924 of six months to South Africa, a detailed study was made of the collections in the museums at Cape Town, Pretoria, Bloemfontein, Grahamstown, Kimberley, and Stellenbosch, in each of which a rich series of fossils is preserved, while the smaller collections in the Port Elizabeth, Maritzburg, Durban, and Buluwayo Museums were also examined. To all those who afforded me the facilities for working at these collections and gave me much assistance in the task, my hearty thanks are due.

The author himself was also able to study to some extent the beds in the field and to collect specimens in the districts of Ceres and De Doorns through the kindness of the farmers and others in those parts.

The old collections in the British Museum which Salter and Sharpe described, together with the recent additions, have been re-examined, and some new material in the Sedgwick Museum, Cambridge, from the Bokkeveld Beds has also been studied.

The comparison of many of the fossils with those from corresponding beds in South America has been rendered easier by the presence of a representative series from the Falkland Islands in the Albany Museum, Grahamstown, and of specimens from Brazil in Dr. A. L. du Toit's collection in Cape Town.

In those cases in which the synonymy of the species has been previously given by Mr. Lake or the author in their descriptions of the fossils in the Annals of the South African Museum, 1903–08, and is still accepted as correct, it is not repeated, but where modifications of the views there expressed have been made, a new list of synonyms and references is given.

We cannot avoid expressing the opinion that many of the species of South African and South American Devonian fossils rest on somewhat insecure foundations, and in some cases it would have been better if no new specific names had been used. For there is often much doubt as to the true characters of the specimens, the types being in a poor or unsatisfactory state of preservation, and even the critical generic characters are sometimes not shown.

* Kozlowski, "Fossiles devoniennes de Brésil," Ann. de Paléont., vol. viii, 1913, pp. 1–19, pls. i–iii; "Foss. Devon. Bolivie," *ibid.*, vol. xii, 1923, pp. 1–112, pls. i–x.

† Newton, Proc. Roy. Phys. Soc. Edinburgh, vol. xvi, 1906, pp. 248–257, pl. x.

Difficulties also arise from want of agreement as to which examples should be regarded as typical, so that the views of authors frequently differ widely as to the limits of the species or the identity of African and American forms. Such obstacles are met with especially in the case of the older established Bokkeveld species, and render a comparison of the fossils less precise than could be wished. But, on the whole, the close resemblance of the Devonian faunas from opposite sides of the South Atlantic is a most noteworthy and conspicuous feature, and the detailed analysis of the Bokkeveld fauna brings out this similarity to a striking extent.

From the fact that the author was fortunate enough to discover several new species and even genera which had not been previously recorded from the Bokkeveld Beds, in the course of his brief visits to certain exposures near Ceres and De Doorns, it is extremely probable that many more additions will have to be made in the future to the fauna of these beds when collecting is more thoroughly and extensively done.

Moreover, when Dr. W. K. Spencer has finished his investigation of the Asteroidea, there will be several new forms to be added to the list of fossils, though as yet he is unable to furnish me even with generic names. The present list of species cannot, therefore, be considered final or exhaustive, but so far as existing material allows it is as complete as possible.

Actinozoa.

Zaphrentis ? zebra, Schwarz.

1906. *Zaphrentis zebra*, Schwarz (pars), Rec. Albany Mus., vol. i, No. 6, p. 360, pl. vii, fig. 12 (1586 Alb. Mus.).

The specimen from the Cockscomb Mountains which Schwarz figured as *Zaphrentis zebra* is in the condition of a distorted internal cast, and therefore not in a satisfactory state of preservation for determination, and even the genus is doubtful. Schwarz's definition is therefore unavoidably incomplete, and it does not apply strictly to the second specimen (1587 Alb. Mus.) which he mentions (but does not figure) under the same name.

Corals are extremely rare in the Devonian beds of the Southern type, and of simple forms Kozlowski * is the only author who

* Kozlowski, "Faune Dev. Bolivie," Ann. Paléont., vol. xii, 1923, p. 97, pl. x, figs. 5–7.

describes a species which comes from Bolivia and is referred to *Cyathophyllum*.

Zaphrentis ? sp.

1906. *Zaphrentis zebra* Schwarz (pars), Rec. Albany Mus., vol. i. pt. 6, p. 360 (*non* pl. vii, fig. 12) (1587 Alb. Mus.).

The second and smaller specimen (1587 Alb. Mus.) of a single coral which Schwarz did not figure was found also in the Cockscomb Mountains. It has much fewer septa than the figured specimen (1586), and the short secondary septa are more regular. The corallum is also more slender, tapering more slowly to the base. As in the other case it is preserved only as a cast, and its generic reference is doubtful.

Striatopora ? sp.

On the slab of rock (H. 67 Stell. Mus.) from Hottentot's Kloof, containing *Lingula scalprum* Clarke, there are a few scattered broken branches of a small ramose coral 10 mm. or more long, apparently rather like the Silurian *Striatopora flexuosa* Hall. The branches are cylindrical and very slender, measuring only about 1 mm. in diameter, and bifurcate occasionally, diverging at about 90°. Traces of the few corallites composing them are visible, and only 3–4 appear to be present on the circumference, the apertures being large, hexagonal or polygonal, with deep vestibules radially striated. None are sufficiently perfect for a detailed description, and the genus is somewhat uncertain.

CYSTIDEA.

Placocystis africanus sp. nov.

(Pl. IV, fig. 1.)

Theca subovoid, truncated at upper end, excavated at lower end for attachment of stem, much compressed dorso-ventrally; lateral edges gently arched, subparallel. Dorsal side flattened, composed of 5 transverse series of plates of unequal side more or less regularly arranged in 4 vertical rows; the lowest series comprises a pair of long subrectangular median basals and a pair of narrower subtriangular lateral basals forming the lower angles of the theca; the second series consists of 4 shorter transversely subquadrate plates; the third series of 4 larger subrectangular plates of which the laterals are oblong and larger than the median ones; the fourth series of 4

or more rather smaller plates of which the inner pair seem to be suboblong (but this part of the theca is poorly preserved), the outer plates are subquadrate and apparently have a small subtriangular plate above them ; the fifth series consists of several small narrow transverse plates, forming an upper marginal band to the theca which bears a short cylindrical spine or brachiole at each corner (?). Surface of plates granulated and ornamented with small tubercles. Ventral face gently convex (imperfectly known) ; the lower plates ornamented with fine, horizontal, closely-set, parallel, laminated lines. Stem slender, cylindrical, about one and a half times the length of theca, composed of a double longitudinal series of about 20 thick subquadrate ossicles with granulated surface.

Dimensions :—

Length of theca	. . .	13·0 mm.
Width ,,	. . .	9·5 ,,

Remarks.—There is only one specimen of this interesting fossil known to me from the Bokkeveld Beds, and it was collected by me at the roadside cutting near Buffelskraal, between De Doorns and Tunnel Siding. The dorsal surface (except near the top) is well preserved and shows many of the plates ; the ventral surface is only exposed near the base where the dorsal surface is broken ; the stem is attached, but the spine-like brachiole on the right-hand side is slightly displaced and only shows as an impression. The left-hand edge of the specimen is slightly imperfect, and the articulation of the stem with the theca is somewhat broken. The arrangement of the plates is more regular than in *Anomalocystis disparilis* Hall * from the upper part of the Oriskany Formation, and seems more like *Placocystis forbesianus* De Kon. Bather † suggests that *A. disparilis* should be referred to *Placocystis* De Koninck, and that *A. cornutus* Hall ‡ from the Helderbergian should be placed in the genus *Ateleocystis* Billings. But Schuchert (*op. cit.*) and Kirk § do not agree with this view, and retain the two American species in *Anomalocystis*. The latter describes the spine-like brachioles at the upper angles of the theca in *A. disparilis* as in *Placocystis* and in our Bokkeveld species, and the stem structure is very similar.

* Schuchert, "Siluric and Devonic Cystidea," Smithsonian Miscell. Coll., vol. xvii, pt. 2, 1904, p. 207, figs. 22*a*, *b*, *id.* Maryland Geol. Surv., Lower Devonian, 1913, p. 228, pl. xxxii, figs. 1–3.

† Bather in Lankester's Treatise on Zoology, pt. 3, 1900, p. 51, text-fig. 13.

‡ Schuchert, *op. cit.*, 1904, p. 206, figs. 21*a*, *b*, pl. xl, figs. 4, 5.

§ Kirk, Proc. Nat. Mus. U.S.A., vol. xli, No. 1846, 1911, pp. 22–26, pl. 3, figs. 9–11.

Blastoidea.

Codaster aff. *pyramidatus*, Shumard.

(Pl. IV, fig. 2.)

Only one fragment of a blastoid has so far been discovered in the Bokkeveld Beds, and it was collected by me from the road-cutting about six miles north of De Doorns in the Hex River Valley, on the way to Tunnel, from the same bed as the cystidean described above. The fragment consists of one of the radial plates of a species of *Codaster*; it is of an elongated hexagonal or pentagonal shape, gently convex from side to side, the long, straight, lateral edges being parallel, and the lower edges slightly concave and meeting at an obtuse angle; the upper end is not perfect, but shows two sets of 16–20 short parallel slits, representing the hydrospires, on each side of a short, broad, sub-triangular, median notch or groove. Fine concentric lines parallel to the lateral edges can also be detected in one place. The length of this plate is 19 mm. and its width 13 mm.

The only recorded example of a blastoid from the Devonian of the southern hemisphere is that figured by Knod * from Bolivia as *Codaster* aff. *pyramidatus* Shumard,† and it much resembles our specimen, differing chiefly in having a less symmetrical outline and in the hydrospires occupying a larger lozenge-shaped area at the upper end as well as being more numerous and decreasing more rapidly in length on each side.

Asteroidea.‡

Echinasterella ? sp.

There are some specimens (3881, 3375 S.A. Mus.) in the South African Museum which may be attributed to this genus and appear to

* Knod, Neues Jahrb. f. Miner. Geol., Beil. Bd. xxv, 1908, p. 565, t. xxviii, figs. 9, 9*a*.

† Shumard, Trans. St. Louis Acad. Sc., 1858, vol. i, pt. 2, pp. 238, 247, pl. ix, figs. 1*a–c*; Etheridge and Carpenter, Catal. Blastoidea Brit. Mus., 1886, p. 266, pl. xii, figs. 1–3.

‡ Dr. W. K. Spencer has been engaged for some years on a study of the Palaeozoic Asteroidea, and has under examination a considerable series of specimens of this group from the Bokkeveld Beds. But his results have not so far been published, and he informs me that at least another year's work is required before he can be certain of the genera.

resemble in many respects *Ech. Darwini* Clarke * from Brazil. Kozlowski † records the genus also from the Devonian of Bolivia.

Aspidosoma ? sp.

A fragmentary asterid (2610 Alb. Mus.) in the Albany Museum may be compared with *Aspidosoma pontis* Clarke,‡ from Brazil, but the specimen is insufficient to decide its reference. Kozlowski § refers a Bolivian fossil to this genus with a query.

Crinoidea.

Ophiocrinus Stangeri, Salter.

1856. *Ophiocrinus Stangeri*, Salter, Trans. Geol. Soc., ser. 2, vol. vii, p. 223, pl. xxv, fig. 20.

The type of this species is in the British Museum. The exact locality is not known.

There is a good specimen of it (2608 Alb. Mus.) in the Albany Museum from Gydo Pass and one in the Pretoria Museum (169 Pret. Mus. type 2) from Montagu. It may be here mentioned that Salter's genus *Ophiocrinus* (1852) is not identical with Angelin's genus (1878) bearing the same name, as Wachsmuth and Springer || pointed out. Bather ¶ has given a precise synopsis of the characters of the genus which he places in the *Rhodocrinidae*.

Crinoid stems.

1856. Crinoidal remains, Salter, Trans. Geol. Soc., ser. 2, vol. vii, p. 223, pl. xxv, figs. 21–28.

Salter figured (but did not describe in detail) various stems and stem-joints of crinoids from the Bokkeveld Beds. Several distinct types can be recognised, and they probably belong to more than one genus. Such imperfect material is represented in all the collections of Bokkeveld fossils from various localities, but detailed descriptions of it are not of much value.

* Clarke, Foss. devon. Parana, 1913, p. 315, pl. xxviii, figs. 9–12.

† Kozlowski, Ann. Paléont., vol. xii, 1923, p. 100, pl. x, fig. 22.

‡ Clarke, Foss. devon. Parana, 1913, p. 312, pl. xxvii, figs. 1–8.

§ Kozlowski, Ann. Paléont., vol. xii, 1923, p. 99, pl. x, fig. 21.

|| Wachsmuth and Springer, "Revision of Palaeocrinoidea," Proc. Acad. Nat. Sc. Philadelphia, 1879, p. 320 ; *ibid.*, 1881, p. 407.

¶ Bather in Lankester's Treatise on Zoology, pt. 3, 1900, p. 201.

Bryozoa.

Fenestella sp.

Only one representative (74*f* S.A. Mus.) of this genus has been recognised in all the collections of Bokkeveld fossils, and this consists of the base of a zoavium and a few branches. The branches are small, parallel, and much thicker than the dissepiments which are set at equal distances apart and form subquadrate or rounded fenestrules longer than wide. Traces of cells can be seen on the branches, and in a length of 6 mm. there are 6–7 fenestrules.

Monotrypa ? sp.

On the same piece of rock (11358) from Leo Hoek, in the British Museum, as that containing the impression of a coarsely rugate *Grammysia* (*Gr. corrugata ?*), there is a portion of a corallum of a small monticuliporoid consisting of small polygonal cells, a few of which seem to be larger and to form indefinite maculae. The only such fossil from the Lower Devonian of the southern hemisphere is *Monotrypa raritabulata* Knod,* described from Bolivia, but ours can hardly be considered identical with it.

Brachiopoda.

Lingula Keideli, Clarke.

1903. *Lingula* aff. *densa* Reed (pars), Ann. S. Afr. Mus., vol. iv, pt. 3, No. 7, p. 167, pl. xx, fig. 1 (120 S.A. Mus.) (*non* fig. 2).

1913. *Lingula Keideli* Clarke, "Foss. devon. Parana," p. 309, pl. xxvi, figs. 8–10.

One (120 S.A. Mus.) of the specimens which the author figured in 1903 as a form allied to *Lingula densa* Hall, may be attributed without any hesitation to *Lingula Keideli* Clarke, described from Brazil. In my figure the beak is made rather too obtuse, and should be more acute, as shown in one of Clarke's specimens, fig. 8. It agrees very closely with Kozlowski's † Bolivian shell which he referred to *L. densa* Hall, and probably is identical with it.

Lingula lepta, Clarke.

1903. *Lingula* aff. *densa* Reed (pars), Ann. S. Afr. Mus. vol. viii, pt. 3, No. 7, p. 167, pl. xx, fig. 2 (123 S.A. Mus.) (*non* fig. 1).

* Knod, Neues Jahrb. f. Miner., Beil. Bd. xxv, 1908, p. 560, t. xxxi, figs. 1, 2.

† Kozlowski, "Foss. devon. Brésil," Ann. Paléont., vol. viii, 1913, p. 3, pl. i, figs. 3–10.

1913. *Lingula lepta*, Clarke, " Foss. devon. Parana," p. 308, pl. xxvi, figs. 3–7.

1913. *Lingula* cf. *Manni*, Kozlowski, " Foss. devon. Brésil," Ann. Paléont., vol. viii, p. 2, pl. i, figs. 1, 2.

Clarke and Kozlowski have identified the South African shells, which the author in 1903 considered allied to *L. densa* Hall, with Brazilian species ; the former gives one a new specific name, but the latter only compares it with the North American species *L. manni* Hall. Both, however, were misled in placing both my figured specimens in the same species, for the second figured one (123 S.A. Mus.) (E. 783 Stell. Mus.) has a much more truncate anterior end than the first one (No. 120 S.A. Mus.) (*op. cit.*, fig. 1), which is referable to Clarke's other species, *L. keideli*. Through the kindness of Dr. du Toit I have been able to compare the specimens with examples which he collected in Brazil. There are specimens in the South African Museum (169*a*, 5415) from Uitvlugt, Montagu, and one in the Stellenbosch Museum (E. 783), which are referable to this species. Another (124) from Tunnel Siding is in the Sedgwick Museum.

Lingula scalprum, Clarke.

(Pl. IV, fig. 3.)

1913. *Lingula scalprum* Clarke, " Foss. devon. Parana," Mon. Serv. Geol. Miner. Brasil, vol. i, p. 310, pl. xxvi, figs. 1, 2.

1923. *Lingula scalprum* Kozlowski, " Foss. devon. Bolivie," Ann. Paléont., vol. xii, p. 81, pl. ix, fig. 25.

There is one good specimen (H. 67 Stell. Mus.) from Hottentot's Kloof, Ceres, which is undoubtedly identical with Clarke's small species *L. scalprum* from Brazil. Kozlowski regards one of the specimens from Bolivia which Knod * included in his *L. subpunctata* as belonging to Clarke's *L. scalprum*.

Lingula (*Glossina ?*) sp.

1903. *Lingula* sp. Reed, Ann. S. Afr. Mus., vol. iv, pts. 3, 7, p. 167, pl. xx, fig. 3 (121 S.A. Mus.).

The small undetermined species of *Lingula* figured by the author from Hottentot's Kloof, Ceres, is of doubtful reference, and may belong to the subgenus or genus *Glossina* Phillips, for it suggests in

* Knod, Neues Jahrb. f. Miner., Beil. Bd. xxv, 1908, p. 536, t. xxvi, fig. 7 (*non* fig. 8).

shape *G. acer* Clarke * from the Grande Grève Limestone of Gaspé, and its allies *L. perlata* Hall, and *L. spatiosa* Hall, of the Helderbergian.

Orbiculoidea (*Roemerella*) cf. *collis*, Clarke.

(Pl. IV, figs. 9, 9*a*.)

There is a large high capuliform brachial valve (6716 S.A. Mus.) of a species of *Orbiculoidea* from the farm Driefontein, Clanwilliam, in the South African Museum, which seems to be comparable to the Brazilian species *O. collis* Clarke † and to *O. montis* Clarke,‡ from the Grande Grève Limestone of Gaspé. Our specimen is somewhat distorted, having been compressed in an antero-posterior direction, so that it measures about 45 mm. in height, about 55 mm. in its antero-posterior diameter, and about 73 mm. in its transverse diameter. The apex is blunt and eccentric, being somewhat nearer the posterior side, towards which it curves slightly back and descends steeply in a gentle concave curve ; the anterior slope is gently arched and convex and also descends steeply, but less so than the posterior face. The shell is ornamented with regular equidistant sharp raised concentric lines which have fine concentric striae in the concave interspaces between them. The surface of the shell is also marked with 5–6 broad flat concentric bands of equal width at distances of every 9–12 concentric lines, indicating periods of growth. Closely placed low rounded equidistant radial lines are visible also on the anterior and posterior slopes of the valve, but they belong to an inner layer of the shell, as may be plainly seen below the apex on the posterior face.

Orbiculoidea (*Roemerella*) *Baini* (Sharpe) (emend.).

1846. *Orbicula* sp. Morris and Sharpe, Proc. Geol. Soc., pl. x, fig. 5, p. 277.

1856. *Orbicula Baini* Sharpe (pars), Trans. Geol. Soc., vol. v, pt. 7, p. 210, pl. xxvi, figs. 21–23 (*non* fig. 20, *nec* diagnosis) (11333, 11334, 11335 Brit. Mus.).

1903. *Orbiculoidea Baini* Reed, Ann. S. Afr. Mus., vol. iv, pt. 4, p. 168, pl. xx, figs. 4, 5, (158 S.A. Mus.).

1913. *Orbiculoidea Baini* Kozlowski, " Foss. devon. Parana," Ann. Paléont., vol. viii, p. 4, pl. i, figs. 11–13.

* Clarke, Mem. No. 9, New York State Mus., pt. 1, 1908, p. 214, pl. xlvii, figs. 7, 8.

† Clarke, Foss. devon. Parana, 1913, p. 306, pl. xxv, figs. 23–26.

‡ Clarke, Mem. 9, New York State Mus., pt. 1, 1908, p. 213, pl. xlvii, figs. 21–24.

1913. *Orbiculoidea Baini* Clarke, "Foss. devon. Parana," p. 301, pl. xxv, figs. 5–15.

1916. *Orbiculoidea* (*Roemerella*) *Baini*, Williams and Breger, Prof. Paper 89 U.S. Geol. Surv., p. 24.

The shell figured by Sharpe in 1856 (fig. 20, *op. cit.*) as a "small specimen," and showing the very fine radial striation which is not present in any of the others, is quite distinct from the shell from the Falkland Isles figured by him in 1846 as *Orbicula* sp., but not named or described at that time. The latter agrees with the shells usually termed *O. Baini*, and as such figured by Sharpe in 1856 (figs. 21–23, *op. cit.*). These have been regarded as typical of the species, and it seems, therefore, inadvisable to substitute a new name for this common form after it has been for so long in general use. But Sharpe's definition is poor and misleading, as he refers to radial striae which are different in nature to those on his "small specimen" (*op. cit.*, fig. 20), as they are on the inner surface or layer of the shell and therefore only visible when the shell is more or less removed or flaked off. Clarke, in 1913 (*op. cit.*), remarked that the Parana shells are wholly devoid of the fine radial surface striation which Von Ammon's * *Discina Baini*, from Matto Grosso, possessed, this shell probably belonging to the same genus, if not species, as *Palaeoscurria Sharpei* (*q.v.*).

In the common Bokkeveld shell illustrated by Sharpe's other figures, 21 to 23 (*op. cit.*), the shell is circular, and the upper (brachial) valve forms a low flattened cone, with the apex subcentral, acute, and elevated to a height equal to almost one-fourth or one-third the diameter. The pedicle valve is slightly concave, and the pedicle foramen is large, oval, and sunken. The surface of the brachial valve, which is usually the one preserved, is covered with sharp equidistant narrow ridges, usually regular and of equal strength, while radial striae are completely absent on the exterior, as Clarke remarked (*op. cit.*), only decorticated specimens showing fine, widely-spaced, radial markings, as may be seen in the British Museum specimen (No. 11333) figured by Sharpe (*op. cit.*, fig. 21). Williams and Breger † compare this species with their *O.* (*Roemerella*) *discus* from the Chapman Sandstone of Maine, and probably *Discina mediorhenana* Fuchs,‡ from the Hunsruck States, and *Orbiculoidea siegenensis* (Kayser),§

* Von Ammon, Zeitschr. Gesell. Erdkunde, vol. xxviii, 1893, p. 359, fig. 4.

† Williams and Breger, Prof. Paper 89 U.S.A. Geol. Surv., 1916, p. 21, pl. vi, figs. 29–33 (? 28).

‡ Fuchs, Abh. k. preuss. geol. Landesanst, 1915, Heft 75, p. 6, t. i, figs. 6–8.

§ Kayser, Jahrb. geol. Landesanst, 1890, p. 95, pl. xi, figs. 1, 2.

from the Siegen Grauwacke and the Siluro-Devonian of Lievin * are allied species.

Orbiculoidea ? aberrans sp. nov.

(Pl. IV, figs. 4, 4*a*.)

Shell slightly obovate, widening a little anteriorly. Brachial valve flat with small, low, rather suddenly raised, sharp, conical apex, situated at about one-sixth the length of the valve from the posterior end. Surface of valve covered with regular equidistant thin flat concentric laminae of equal strength, having their surface slightly undulated or weakly pitted, and all crossed by very delicate close radial striae. Substance of shell thin, corneous.

Dimensions (289 *a*, *b*, Univ. Cape) :—

Length . . .	18·0 mm.
Width (max.) . .	16·5 mm.

Remarks.—There is only one specimen of this interesting shell which was collected from Keurbosch, Hex River district, and it is in the Cape University Collection (289 *a*, *b*). The impression of the exterior is also preserved. The pitting or undulation of the surface of the successive laminae gives a peculiar frilled appearance under a lens. The true generic position is questionable, but it somewhat resembles *Schizobolus truncatus* (Hall) † of the black Genesee shales of New York, a species which Clarke ‡ also records and figures from the Devonian of Brazil.

Orthis (*Dalmanella*) *satelles* sp. nov.

(Pl. IV, fig. 5.)

Shell transversely subcircular, rather wider than long, plano-convex or concavo-convex ; cardinal angles rounded ; hinge-line short, about half width of shell. Pedicle valve gently convex ; beak small, elevated, with lateral edges inclined at about 120° ; hinge-area triangular, of moderate size, concave, inclined nearly at right angles to plane of valve. Brachial valve flattened or slightly concave, with a more or less distinct broad shallow median sulcus. Surface of valves covered with numerous primary subangular equal riblets, gently curved back near cardinal angles, increasing by rare inter calation of shorter ribs to 50–60 on margins.

* Barrois, Pruvost, and Dubois, Mém. Soc. Geol. Nord, vi, 2, fasc. 2, 1920, p. 76, pl. x, figs. 13, 14.

† Hall and Clarke, Palaeont. New York, vol. viii, Brach. I, p. 87, pl. iii, figs. 11–14.

‡ Clarke, *op. cit.*, 1913, p. 325, pl. xxv, figs. 1–4.

Dimensions :—

	(7203 S.A. Mus.)	(138*a* S.A. Mus.)
Length . . .	11·0 mm.	10·5 mm.
Width . . .	14·5 mm.	13·5 mm.

Remarks.—Several specimens of this species of *Orthis* occur in the South African Museum (138*a*, 7203, 15), collected 200 yds. from Triangle Station and (6721 S.A. Mus.) from Gydo Pass, and there is one also in the Pretoria Museum (414 Pret. Mus.) from Ezelfontein, Ceres. It is allied to, but hardly identical with, *O.* (*Dalm.*) *Pradoi* Kozl.* from the Bolivian Devonian, and it resembles also *O.* (*Dalm.*) *lucia* Billings † of the North American Lower Devonian. Williams and Breger ‡ put *O.* (*Dalm.*) *plano-convexa* Hall, of the Lower Helderberg, Oriskany, and Chapman Sandstone, in the same genus as *O. lucia*, and consider it almost indistinguishable from the European Lower Devonian species commonly called *O. orbicularis* Sow.

Stropheodonta Arcei (Ulrich).

(Pl. IV, fig. 11.)

1856. *Chonetes ?* sp. Sharpe (pars), Trans. Geol. Soc., ser. 2, vol. vii, p. 210 (" from nodule of reddish rock ").

1893. *Chonetes Arcei* Ulrich, Neues Jahrb. f. Miner., Beil. Bd. viii, p. 77, pl. iv, figs. 35, 36.

1903. *Chonetes* cf. *Arcei* Reed, Ann. S. Afr. Mus., vol. iv, pt. 3, p. 173, pl. xxi, fig. 3 (129 S.A. Mus.).

1908. *Stropheodonta Arcei* Knod, Neues Jahrb. f. Miner., Beil. Bd. xxv, p. 539.

1913. *Stropheodonta* cf. *Arcei* Kozlowski, " Foss. devon. Brésil," Ann. de Paléont., vol. viii, p. 6, pl. xii (2), figs. 3, 4.

This species, which was put in the genus *Chonetes* by its founder, was transferred to *Stropheodonta* by Knod, and Kozlowski (*op. cit.*) adopts this reference. With this view I am in agreement. The specimen (129 S.A. Mus.) which I figured in 1903 as comparable to this Bolivian species may, without much doubt, be assigned to it, and there are some specimens in the British Museum (B. 45502, 11357) from Warm Bokkeveld which show all the characters distinctly, and include the

* Kozlowski, *op. cit.*, 1923, p. 82, pl. x, figs. 17, 18.

† Clarke, Mem. 9, New York State Mus., pt. 1, 1908, p. 204, pl. xliv, figs. 8–20.

‡ Williams and Breger, *op. cit.*, 1916, p. 57, pl. vi, fig. 17 ; pl. vii, figs. 10, 11, 13, 14, 16–18, 20–22, 24–30.

specimen mentioned by Sharpe (*op. cit.*) as *Chonetes?* sp. Clarke * does not consider that Knod is justified in referring this species to *Stropheodonta,* and the Argentine shell described by Thomas † as *Chonetes Arcei,* and possessing a denticulate hinge-line, is regarded by Clarke as "clearly an *Eodevonaria,*" which is a subgenus of *Chonetes.*

Stropheodonta cf. *Katzeri,* Knod.

(Pl. IV, fig. 10.)

? 1856. *Chonetes* sp. ind. Sharpe (pars), Trans. Geol. Soc., ser. 2, vol. vii, p. 210.

? 1893. *Strophomena* sp. α, Ulrich, Neues Jahrb. f. Miner. Geol., Beil. Bd. viii, p. 70, t. iv, fig. 23.

1893. *Strophomena* sp. β, Ulrich, *op. cit.*, p. 70, t. iv, fig. 24.

1903. *Strophonella* sp. Reed, Ann. S. Afr. Mus., vol. iv, pt. 3, p. 169, pl. xx, fig. 7 (128 S.A. Mus.).

1908. *Stropheodonta Katzeri* Knod, Neues Jahrb. f. Miner. Geol., Beil. Bd. xxv, p. 538, t. xxvii, figs. 1–3*a*.

There is one good example of the interior of a pedicle valve in the Stellenbosch Museum (H. 196 Stell. Mus.) from 2 miles N.E. of Ceres, measuring about 43 mm. in width and 29 mm. in length. It shows the internal characters well, especially the coarse radial pustulation as illustrated by Knod and Ulrich in his sp. β. Some specimens in the British Museum from the Warm Bokkeveld more resemble Ulrich's sp. α, which Knod would include in *Str. Katzeri.* The coarsely radiate, indefinite, large, diductor muscle-scars are well seen in some other specimens just as Knod figures and describes them. If Knod is correct in referring Ulrich's *Strophemena* sp. α to *Str. Katzeri,* we may, without much hesitation, place in it the Bokkeveld fossil termed *Strophonella* sp., which the author figured under that name in 1903. Certain poor specimens from Hottentot's Kraal (3903, 3904, 3923, S.A. Mus.) which were at first thought to be comparable with *Chonetes Hallei* Clarke,‡ from the Falkland Isles, may also be doubtfully included in *Str. Katzeri.* Knod (*op. cit.*) compares his species with *Str. magnifica* Hall § of the Oriskany Formation.

* Clarke, Foss. devon. Parana, 1913, p. 290.

† Thomas, Zeitschr. deut. geol. Gesell., vol. lvii, 1905, p. 258, t. xiii, figs. 26*a*–*c*.

‡ Clarke, *op. cit.*, 1913, p. 293, pl. xxiv, fig. 34.

§ Hall, Palaeont. New York, vol. iii, 1859, pp. 414, 482, pl. xciii, fig. 4; pl. xciv, fig. 2; pl. xcv, fig. 8; pl. xcv*a*, figs. 15–19.

Stropheodonta (*Leptostrophia*) *concinna* (Morris and Sharpe).

1903. *Stropheodonta* cf. *concinna*, Reed, Ann. S. Afr. Mus., vol. iv, pt. 3, p. 169, pl. xx, fig. 6 (131 S.A. Mus.).

1913. *Leptostrophia concinna*, Clarke, "Foss. devon. Parana," p. 285, pl. xxiii, figs. 1–4.

It may be doubted, according to Clarke,* if this species is really allied to *Str.* (*Lept.*) *perplana* Conr., and the identification of the latter species in Bolivia is questionable. Knod,† however, considers them to be very closely allied, and Williams and Breger ‡ put them as identical, or as belonging to the same genus, but with a query. It appears to be a very rare form in the Bokkeveld Beds.

Schuchertella Sulivani (Morris and Sharpe).

1903. *Orthothetes Sulivani* Reed (pars), Ann. S. Afr. Mus., vol. iv, pt. 3, p. 170, pl. xx, fig. 8 (113 S.A. Mus.) (for earlier references).

1913. *Schuchertella Sulivani* Clarke, "Foss. devon. Parana," p. 279, pl. xxiii, figs. 16–23.

The two specimens (11330, 11331 Brit. Mus.) which Sharpe figured from the Bokkeveld Beds are from the Warm Bokkeveld, and specimens from other localities are fairly common in the South African Museum and in other collections.

With regard to its affinities, Clarke § does not agree with the author's suggestion that *S. Agassizi* (Hartt) is probably identical with it, and he separates the Brazilian form as a distinct species, and Kozlowski ‖ likewise keeps the name *S. Agassizi* for certain Bolivian shells which Knod ¶ had referred to *O. chemungensis*. Williams and Breger ** consider that *S. Sulivani* belongs to the same group as the European *S. hipponyx* (Schnur). The shell which has been described as *S. pecten* from the Siluro-Devonian rocks of Lievin †† may also be allied.

* Clarke, *op. cit.*, 1913, p. 289.

† Knod, *op. cit.*, 1908, p. 540, t. xxvii, fig. 4.

‡ Williams and Breger, *op. cit.*, 1916, p. 27.

§ Clarke, *op. cit.*, 1913, p. 276, pl. xxiii, figs. 5–13.

‖ Kozlowski, *op. cit.*, 1923, p. 85, pl. ix, fig. 30.

¶ Knod, *op. cit.*, 1908, p. 541, pl. xxvi, figs. 13, 14; pl. xxvii, figs. 5, 7.

** Williams and Breger, *op. cit.*, 1916, p. 39.

†† Barrois, Pruvost, and Dubois, Mém. Soc. Geol. Nord, vi, 2, fasc. 2, 1920, p. 82, pl. xii, figs. 4, 5.

Schuchertella ? Baini (Sharpe).

1856. *Strophomena Baini* Sharpe, Trans. Geol. Soc., ser. 2, vol. vii, p. 208, pl. xxvi, fig. 13 (11325 Brit. Mus.), fig. 17 (11329 Brit. Mus.).
1903. *Orthothetes Sulivani* Reed (pars), Ann. S. Afr. Mus., vol. iv, pt. 3, p. 170 (*non* pl. xx, fig. 8).
? 1908. *Orthothetes chemungensis* Knod, Neues Jahrb. f. Miner. Geol., Beil. Bd. xxv, p. 541, t. xxvi, figs. 13, 14, 14*a*.

The type of *Sch. Baini* (Sharpe) which is in the British Museum (11325) is a brachial valve from the Warm Bokkeveld, which precisely agrees with Knod's figure of a Bolivian shell which he attributes to *O. chemungensis* Conr. Kozlowski * considers this Bolivian shell to belong to *Sch. Agassizi* (Hartt), and puts Clarke's *Sch. Agassizi* from Brazil with it, including them all under the latter name, but he does not quote Sharpe's *Sch. Baini* in the synonymy. In 1903 the author was inclined to consider *Sch. Baini* as inseparable from *Sch. Sulivani*; but the latter is a more compressed and more subcircular or subquadrate form and has coarser radial riblets, and is more likely to be identical with *Sch. Agassizi*; Kozlowski's and Clarke's figures of this species show these characters well. The absence in *Sch. Sulivani* of the decided bilobation of the brachial valve, which is a marked feature in *Sch. Baini*, is another distinction. But we know nothing of its internal characters. Sharpe's figure 13 (11325 Brit. Mus.) makes the radii too fine, and there are only about 120 on the surface; these have reached this number by intercalation of rather finer ones at various distances from the beak. This specimen measures 25 mm. in width and 18 mm. in length. The other figured specimen (*op. cit.*, fig. 17, 11329 Brit. Mus.) is an impression of a valve on the same piece of rock, and is of larger size, but it is broken and has rather coarser radii and more obtuse cardinal angles, and it may belong to another species.

Chonetes falklandicus, Morris and Sharpe.

1903. *Chonetes falklandicus* Reed, Ann. S. Afr. Mus., vol. iv, pt. 3, p. 171, pl. xx, figs. 9, 10 (136, 127 S.A. Mus.) (for earlier references).
1908. *Chonetes falklandicus* Knod, Neues Jahrb. f. Miner., Beil. Bd. xxv, p. 545.

* Kozlowski, *op. cit.*, 1923, p. 85, pl. ix, fig. 30.

1913. *Chonetes falklandicus* Clarke (pars), "Foss. devon. Parana," p. 295, pl. xxiv, figs. 8, 12, 14, 22, 23 (? *non cet.*).

? 1913. *Chonetes falklandicus* Kozlowski, Ann. Paléont., vol. viii, p. 7, pl. xii (2), fig. 5.

Clarke included under this name a series of specimens from the Devonian of Brazil which showed a considerable range of variation, and, judging from his figures, there may be more than one species present. Specimens from the Falkland Isles (3223, 3222 Alb. Mus.) in the Grahamstown Museum, and others from Brazil in Dr. du Toit's collection in Cape Town, have enabled me to make a comparison with the Bokkeveld material, and it has not led me to adopt Clarke's wide interpretation of this species.

It is probable that one (11324 Brit. Mus.) at any rate of the specimens figured by Sharpe * from the Warm Bokkeveld as *Chonetes* sp. indet. may be referred to *Ch. falklandicus*, and it is not unlikely that the others (11326, 11327 Brit. Mus.) also figured by him (*op. cit.*, figs. 15, 16) should be associated; but they are poorly preserved.

As Williams and Breger † have remarked, the North American species, *Ch. novascoticus* Hall,‡ and the European *Ch. sarcinulatus* Auctt., are allied to *Ch. falklandicus*, and we may also mention *Ch. canadensis* Billings,§ from the Grande Grève Limestone of Quebec, in this connection.

Chonetes Rücki Ulrich, var. nov. *medialis*.

(Pl. IV, figs. 7, 8.)

Shell flattened, semi-elliptical; cardinal angles subrectangular; cardinal line equal to width of shell, armed with 3 long spines on each side of beak, directed nearly at right angles to hinge-line, with the longest one nearest the cardinal angle; surface of shell covered with fine low rounded thread-like radii, increasing by intercalation and bifurcation to 100–120 on margin, with one stronger median radius. Pedicle valve with short thin median septum, and pair of short broadly flabelliform rounded diductors about one-fourth the length of the valve; interior covered with radial lines of small equal equidistant punctae.

* Sharpe, Trans. Geol. Soc., ser. 2, vol. vii, 1856, pl. xxvi, fig. 14.

† Williams and Breger, *op. cit.*, 1916, p. 47.

‡ *Ibid.*, p. 45, pl. ix, figs. 11, 12, 15, 16, 19; pl. x, figs. 1–3, 5–16, 18–29, 32, 33 (and references).

§ Clarke, Mem. 9, New York State Mus., pt. 1, 1908, p. 205, pl. xlv, figs. 16–27.

Dimensions (207 Univ. Cape) :—

Length . . .	8·0 mm.
Width . . .	10·0 mm.

Remarks.—The impression and internal cast of a pedicle valve of a small species of *Chonetes* (207 Univ. Cape) from Touws River Road, Upper Hex River Valley, may probably be regarded as a variety of *Ch. Rücki* Ulrich,* to which Ulrich (*op. cit.*) considered that *Ch. coronata* Conr. was allied, and that probably *Ch. Comstocki* Hartt, from the Devonian of Brazil, was identical. But the median rib in ours recalls *Ch. aroostookensis* Clarke † from the Chapman Sandstone of Maine. Some of Clarke's ‡ Brazilian specimens attributed to *Ch. falklandicus* appear to bear a considerable resemblance to our form.

Chonetes Stübeli, Ulrich.

1893. *Chonetes Stübeli* Ulrich, Neues Jahrb. f. Miner., Beil. Bd. viii, p. 80, t. v, figs. 3, 4.

1903. *Chonetes* aff. *setiger* Reed, Ann. S. Afr. Mus., vol. iv, pt. 3, p. 174, pl. xxi, fig. 4 (5 ?) (126 S.A. Mus.).

1908. *Chonetes Stübeli* (Ulrich ?) Knod, Neues Jahrb. f. Miner., Beil. Bd. xxv, p. 546.

From a further examination of the specimens (126 S.A. Mus.) from the Witzenberg Valley, Ceres, which I regarded as allied to *Ch. setiger* Hall, and from better acquaintance with the latter species, it is practically certain that the Bokkeveld shells should be referred to *Ch. Stübeli* Ulrich of the Bolivian Devonian, a species which its author considers allied to *Ch. mucronata* Hall, and that they should not be placed with *Ch. coronata* Conr., as Clarke § thinks. Some of the more coarsely ribbed shells from Brazil figured by Clarke || as *Ch. falklandicus* Morr. and Sh., may possibly be referred to *Ch. Stübeli.* The species *Ch. vicinus* Cast. and *Ch. Billingsi* Clarke,¶ both of the North American Lower Devonian, belong to the same group of species as *Ch. mucronata,* and the variety of *Ch. vicinus* Cast. from the Chapman Sandstone figured by Williams and Breger ** as *deflecta* Hall, bears a great resem-

* Ulrich, Neues Jahrb. f. Miner. Geol., Beil. Bd. viii, 1893, p. 79, t. v, figs. 1, 2.

† Clarke, Mem. 9, New York State Mus., pt. 2, 1909, p. 120, pl. xxx, figs. 20–25.

‡ Clarke, Foss. devon. Parana, 1913, pl. xxiv, figs. 19, 24 (*non cet.*).

§ *Ibid.*, pp. 299, 300.

|| *Ibid.*, pl. xxiv, figs. 3, 4, 5.

¶ Clarke, Mem. 9, New York State Mus., pt. 1, pp. 209, 238, pl. xli, figs. 18–30.

** Williams and Breger, *op. cit.*, p. 49, pl. iii, fig. 8.

blance to the South African shell. Our figured specimen (126 S.A. Mus.) shows the cardinal spines distinctly. Another specimen in the Sedgwick Museum, collected by Dr. Rastall from De Doorns, consists of the impression of the exterior of the pedicle valve beautifully preserved.

Chonetes cf. *Hallei*, Clarke.

(Pl. IV, fig. 12.)

1856. *Chonetes ?* sp. Sharpe (pars), Trans. Geol. Soc., ser. 2, vol. vii, p. 210.

1913. *Chonetes Hallei*, Clarke, "Foss. devon. Parana," p. 293, pl. xxiv, fig. 34.

On a reddish nodule from Warm Bokkeveld in the British Museum (B 45502) there is the impression of the interior of a nearly perfect brachial valve of a subquadrate shell which seems almost indistinguishable from *Chonetes Hallei* Clarke, from the Falkland Islands. The marginal band of fine radial lines of pustules, the much coarser pustulation of the inner portion of the valve, the course and strength of the brachial ridges, the dental sockets and adductor muscle-scars, agree completely. But there is a more distinct low median septum in our specimen, and the large stout cardinal process is bilobed, not trilobed, as Clarke states. It does not seem that this is a true *Chonetes*.

Dimensions :—

Length	. . .	*c.* 32 mm.
Width	. . .	20 mm.

Chonetes sp.

1903. *Chonetes* cf. *coronatus*, Reed, Ann. S. Afr. Mus., vol. iv, pt. 3, p. 172, pl. xx, figs. 11, 12; pl. xxi, figs. 1, 2 (112, 118 S.A. Mus.).

The rather distorted poor casts (112, 118 S.A. Mus.) from Boschluis Kloof, which the author in 1903 compared with *Ch. coronatus* Hall, are certainly different to those from Argentina identified by Thomas * as belonging to this species. Clarke † considered my comparison to be hazardous, and Thomas' Argentine shells are more allied to *Ch. falklandicus* and *Ch. Rücki* Ulr. from Bolivia. But Ulrich ‡ himself remarked that the latter stood near *Ch. coronatus*. Some of the specimens figured by Clarke § from the Falkland Islands under the

* Thomas, Zeitschr. deut. geol. Gesell., vol. lvii, 1905, p. 259, t. xix, figs. 39, 40.

† Clarke, *op. cit.*, 1913, p. 301.

‡ Ulrich, *op. cit.*, 1893, p. 79, t. v, figs. 1, 2.

§ Clarke, *op. cit.*, 1913, p. 291, pl. xxiv, figs. 26–33.

new specific name *Ch. Skottsbergi,*—a form which he considers allied to the Hamilton species *Ch. coronatus* Hall and *Ch. syrtalis* Hall, and to *Ch. canadensis* Billings of the Grande Grève Limestone and Chapman Sandstone—somewhat resemble our Bokkeveld specimens, which are too poor for a satisfactory determination. Raymond's * series of specimens illustrating the developmental changes of *Ch. coronatus* include some (*op. cit.*, pl. xvi, rows 3 and 4) much resembling our shells.

Chonetes (*Eodevonaria*) aff. *arcuata*, Hall.

(Pl. IV, fig. 13.)

One internal cast of a pedicle valve (C 10) occurs in the Stellenbosch Museum in an unusually good condition, but unfortunately its locality is unknown. The valve is transversely semi-elliptical with subrectangular cardinal angles ; its surface is uniformly convex, and it is rather inflated in the antero-posterior direction. The beak is small, pointed, and incurved. The teeth are short and stout ; the diductor muscle-scars are large and subcircular, more than half the length of the shell, and there is a low median septum between them, thickened in the middle and extending about four-fifths the length of the valve, dying out gradually anteriorly. Behind the diductor muscle-scars and between them and the hinge-line are transverse laterally extended sublanceolate smooth areas representing internal thickenings of the shell. There are about 150 fine equal radial thread-like lines on the surface of the shell, increasing near the margin by intercalation (and bifurcation ?), and on the cast lines of small equidistant punctae lie between them. The hinge-line does not show any distinct cardinal spines, and there are only doubtful traces of fine crenulations on the hinge-line. But on another specimen from Boschluis Kloof in the Sedgwick Museum the oblique crenulations are distinctly visible, as in *Ch. arcuata* Hall of the Corniferous Limestone, and *Ch. hudsonica* Clarke † of the Oriskany and Gaspé Sandstones, particularly the *Ch.* cf. *arcuata* of the Oriskany of New York figured by Clarke.‡ One of the shells from Brazil figured by Clarke § as belonging to *Ch. falklandicus*, but quite different to the ordinary form of that species, bears a considerable resemblance. The European

* Raymond, Amer. Journ. Sc., vol. xvii, 1904, p. 289, pl. xvi.

† Clarke, Mem. 9, New York State Mus., pt. 1, 1908, p. 238, pl. xlv, figs. 6–15.

‡ *Ibid.*, pt. 2, 1909, p. 144, pl. xxxiv, figs. 21–31 ; Kindle, Bull. 508, U.S. Geol. Surv., 1912, p. 73, pl. iii, figs. 9–12.

§ Clarke, Foss. devon. Parana, 1913, pl. xxiv, fig. 18 (*non cet.*).

species *Ch. dilatata* Roem.* from the Coblenzian belongs to the same group as *Ch. arcuata*, as Williams and Breger have observed.†

Spirifer antarcticus, Morris and Sharpe.

1842. *Spirifer antarcticus* Morris and Sharpe, Quart. Journ. Geol. Soc., vol. ii, p. 276, pl. xi, fig. 1.

? 1846. *Spirifer orbignii*, Morris and Sharpe, *ibid.*, p. 276, pl. xi, figs. 3*a*, *b*, *c*.

1856. *Spirifer antarcticus* Sharpe, Trans. Geol. Soc., ser. 2, vol. vii, p. 206, figs. 1, 2, 5.

1856. *Spirifer orbignii* Sharpe, *ibid.*, p. 207, pl. xxvi, figs. 3, 4, 6.

1893. *Spirifer chuquisaca* Ulrich, Neues Jahrb. f. Miner. Geol., Beil. Bd. viii, p. 65, t. iv, figs. 19, 20 *a–c*.

? 1897. *Spirifer antarcticus* Kayser, Zeitschr. deut. geol. Gesell., vol. xlix, p. 297, t. ix, figs. 1–4.

1903. *Spirifer orbignyi* Reed (pars), Ann. S. Afr. Mus., vol. iv, pt. 3, p. 180 (*non* pl. xxii, fig. 4).

1903. *Spirifer* cf. *pedroanus* Reed, *ibid.*, p. 183, pl. xxii, fig. 5 (160 S.A. Mus.).

1905. *Spirifer antarcticus*, Thomas (pars), Zeitschr. deut. geol. Gesell., Bd. lvii, p. 261, t. xiii, figs. 22–24 (*non* f. 25).

1906. *Spirifer antarcticus* Newton, Proc. Roy. Phys. Soc. Edin., vol. xvi, p. 252, pl. x, figs. 1–10.

1906. *Spirifer antarcticus* Schwarz (pars), Rec. Albany Mus., vol. i, pt. 6, p. 371 (*non* pl. vii, figs. 1, 2).

1908. *Spirifer orbignyi* Reed, Ann. S. Afr. Mus., vol. iv, pt. 8, p. 399.

1908. *Spirifer arrectus* var. *antarcticus* Knod, Neues Jahrb. f. Miner. Geol., Beil. Bd. xxv, p. 549, t. xxviii, figs. 3, 3*a*.

1908. *Spirifer arrectus* var. *acuticostatus* Knod, *ibid.*, p. 547, t. xxviii, fig. 2.

1913. *Spirifer antarcticus* Clarke, "Foss. devon. Parana," p. 258, pl. xviii, figs. 1–14 (*non* 15, 16).

1923. *Spirifer antarcticus* Kozlowski, "Faune dev. Bolivie," Ann. Paléont., vol. xii, p. 93.

The above is a revised synonymy, for the author has been led to modify his views since 1903. Clarke (*op. cit.*, 1913, pp. 230, 231) considers that *Sp. orbignyi* Morris and Sharpe was so inadequately

* Fuchs, "Hunsrucksch. u. Unterkoblenzsch. am Mittelrhein," Abh. k. preuss. geol. Landesanst N.F., Heft 79, 1915, p. 19, t. iv, figs. 3–10.

† Williams and Breger, *op. cit.*, 1916, pp. 53, 54, pl. iii, figs. 6, 9, 11.

defined that its true characters are questionable, and that though the specific name has been thought to have the priority of *antarcticus*, it is best to employ the latter name with which the South African shells certainly agree. With this view most authors concur, and the present author feels therefore bound to do so also and abandon his earlier position. Newton (*op. cit.*, 1906) arrived at the same conclusion. The classification of the South African forms is, however, less easy than that of the South American shells, for which Clarke relies chiefly on their ornamentation. But unfortunately most of the Bokkeveld specimens do not show it and occur as internal casts. Thus considerable difference of opinion may reasonably exist as to their reference and relation.

In 1907 * the author expressed the view that the shell which he had previously termed *Sp.* cf. *pedroanus* might be only a variety of *Sp. antarcticus*. Clarke, however, thinks that it approaches *Sp. Hawkinsi* Morris and Sharpe (though this species has only 3 ribs on each side of the sinus instead of 20–22), while Knod (*op. cit.*) places it in his variety *acuticostatus*. Scupin,† in 1898, pointed out that the group of species comprising *Sp. arrectus* Hall (=*Sp. Murchisoni* Castelnau) was the American representative of the European group containing *Sp. primaevus*, and Clarke,‡ in 1907, declared that both *Sp. antarcticus* and *Sp. orbignyi* were merely local expressions of the widely distributed type *Sp. arrectus*. Williams and Breger,§ however, maintain that the typical *Sp. antarcticus* of the Falkland Isles does not belong to the group of *Sp. arrectus* (=*Sp. Murchisoni* Cast.), but rather to the group of *Sp. Hercyniae*, *Sp. Murchisoni* never having more than 8 distinct ribs on each side; and they believe that my *Sp. orbignyi* belongs to the type of *Sp. gaspensis* Billings.‖ But my *Sp.* cf. *pedroanus* is more of the type which belongs (as Clarke ¶ stated) to the *Sp. Murchisoni* group. The varieties of *Sp. Murchisoni* and the South African species are discussed by Williams and Breger (*op. cit.*, pp. 98–104) without coming to any satisfactory conclusion.

Although we may be chary of separating off the South African *Spirifers* into distinct species, we can at any rate recognise certain more or less definite varieties in the somewhat polymorphic or hetero-

* Reed, Geol. Mag., Dec. v, vol. iv, 1907, p. 35.

† Scupin, Zeitschr. deut. geol. Gesell., vol. l, 1898, p. 462, t. xvii, figs. 2–4.

‡ Clarke, Bull. 107, New York State Mus., pp. 260–263.

§ Williams and Breger, *op. cit.*, 1916, pp. 101–104.

‖ Williams and Breger, *ibid.*, p. 107, pl. iv, fig. 7.

¶ Clarke, Mem. 9, New York State Mus., pt. 1, 1908, p. 235, pl. xxxi, figs. 29–38.

geneous group comprised under the name *Sp. antarcticus*, the varieties being distinguishable by their shape and number and character of their ribs rather than by their ornamentation. But it is frequently difficult or impossible to sort the poorly preserved or fragmentary specimens which are commonly obtained from the Bokkeveld Beds into such varieties. Clarke * has insisted that external sculpture is the "most dependable of structural features" in the case of the plicated Eodevonian species, and he considers that most authors have been misled in dealing with the austral members of the genus by neglecting this character. One of the best preserved examples of the minute ornamentation of the surface of a specimen from the Bokkeveld Beds is one in the British Museum (I. 858) from Keurbooms River, Plettenberg Bay, showing the impression of part of a crushed and distorted pedicle valve; the whole surface is covered with fine radial striae crossed by finer concentric lines closely placed and bearing at their intersections small granules or spinules, which thus form regular radial rows, just as Clarke describes, and this type of ornamentation is considered by him as highly distinctive of the austral species.

Spirifer antarcticus, Morris and Sharpe, var. nov. *gamkaensis*.

1903. *Spirifer* sp. *a*, Reed, Ann. S. Afr. Mus., vol. iv, pt. 3, p. 184, pl. xxiii, fig. 2 (146 S.A. Mus.).

1906. *Spirifer orbignyi* Schwarz (pars), Rec. Albany Mus., vol. i, pt. 6, p. 370, pl. vii, fig. 4 (2128 Alb. Mus.).

1913. *Spirifer antarcticus* Clarke (pars), "Foss. devon. Parana," p. 562, pl. xviii, figs. 15, 16 (*non cet.*).

This variety has a deeply triangular shell, less transverse than the typical forms of the species; the cardinal angles are broadly pointed or subrectangular; there is a rather narrow median sinus increasing very slowly in width anteriorly, and the subangular or angular ribs on each side of it number 9–10 and are narrow. The median sinus is not equal to more than 2–2½ ribs in width at the margin. The much-extended transverse alate typical form of *Sp. antarcticus* with acutely pointed lateral angles is easily distinguishable from this variety when we have well-preserved specimens to deal with. One of the specimens from the Falkland Isles figured by Newton † as *Sp. antarcticus* appears to belong to this variety, judging from its shape and ribbing. It bears

* Clarke, *op. cit.*, 1913, pp. 222–224.

† Newton, *op. cit.*, pl. x, fig. 4.

a considerable resemblance to *Sp. Murchisoni* Castelnau * of the Lower Devonian of North America. Clarke in 1908 was inclined to think that the differences between the allied forms of *Spirifer* of this group were more constant than he and Scupin had previously believed. But having so many imperfect specimens with transitional characters in the Bokkeveld collections it seems wiser not to separate the South African forms as species.

Spirifer antarcticus Morris and Sharpe, var. *kayseriana*, Clarke.

1856. *Spirifer orbignyi* Sharpe, Trans. Geol. Soc., ser. 2, vol. vii, p. 207, pl. xxvi, fig. 1 (*non cet.*).

1903. *Spirifer orbignyi* Reed (pars), Ann. S. Afr. Mus., vol. iv, pt. 3, p. 180, pl. xxii, fig. 4 (147 S.A. Mus.).

? 1906. *Spirifer orbignyi*, Schwarz (pars), Rec. Albany Mus., vol. i, pt. 6, p. 370, pl. vii, fig. 3 (2128 Alb. Mus) (*non cet.*).

1906. *Spirifer antarcticus*, Schwarz (pars), *ibid.*, p. 371, pl. vii, fig. 1 (134 Alb. Mus.).

1913. *Spirifer kayserianus* Clarke, "Foss. devon. Parana," p. 252, pl. xix, figs. 1–15.

1913. *Spirifer arrectus* Kozlowski (pars), "Faune dev. Brésil," Ann. Paléont., vol. viii, p. 7, pl. ii, figs. 7, 10 (*non* 6, 8, 9).

The Brazilian shell which Clarke separated off as a distinct species under the name *Sp. kayserianus* on the strength of its ornamentation seems to be rather abundantly represented in the Bokkeveld fauna (1160, 3888, 827, 3803 S.A. Mus.) by specimens which have usually been included in *Sp. orbignyi* (=*antarcticus*), but the fewer broader and more rounded ribs, becoming weaker near the cardinal angles, apart even from the ornamentation, serve to distinguish it, at any rate as a variety, though internal casts are generally difficult to identify. The ornamentation is beautifully preserved in a specimen (422 Pret. Mus.) from Boschluis Kloof in the Pretoria Museum, the fine radial lines bearing small granules at the intersections of the finer concentric lines which become coarser and lamellose near the margins of the shell. Probably some of the shells described by other authors from the South American Devonian under other names belong to this variety. A transversely expanded form is represented by two specimens (3806, 3804 S.A. Mus.) in the South African Museum from Hottentot's Kraal, Ceres, the former measuring 32 mm. in length and 75 mm. in width, with very acute cardinal angles. The specimen (11313 Brit.

* Clarke, Mem. 9, New York State Mus., pt. 1, 1908, p. 177, pl. xxxii, figs. 1–10.

Mus.) from the Warm Bokkeveld figured by Sharpe as *Sp. orbignyi* (*op. cit.*, pl. xxvi, fig. 1) is probably referable to this variety, and so may be several of the shells from the Falkland Islands which Newton * figures as *Sp. antarcticus.* It seems as if the shell from the Moose River Sandstone, Maine, which Clarke † described as *Sp. primaevus* Stein, var. *atlantica*, is closely allied to this southern form, as Clarke himself remarks.

Spirifer Ceres, Reed.

1903. *Spirifer Ceres* Reed (pars), Ann. S. Afr. Mus., vol. iv, pt. 3, p. 184, pl. xxii, fig. 7 (144 S.A. Mus.), pl. xxiii, fig. 1. (148 Cape Mus.), *non* pl. xxii, fig. 6 (145 S.A. Mus.).

? 1903. *Spirifer* (*Reticularia ?*) sp. Reed, *ibid.*, p. 185, pl. xxiii, fig. 4 (139 S.A. Mus.).

1905. *Spirifer antarcticus* Thomas (pars), Zeitschr. deut. geol. Gesell., vol. lvii, p. 261, t. xiii, fig. 25 (*non cet.*).

1906. *Spirifer ceres* Schwarz, Rec. Albany Mus., vol. i, pt. 6, p. 375, pl. vii, fig. 6 (49 Alb. Mus.).

1908. *Spirifer arrectus* var. *Hawkinsi* Knod, Neues Jahrb. f. Miner. Geol., Beil. Bd. xxv, p. 549, t. xxviii, fig. 1.

1913. *Spirifer ceres*, Clarke, " Foss. devon. Parana," p. 232.

1913. *Spirifer arrectus* Kozlowski (pars), " Foss. dev. Brésil," Ann. Paléont., vol. viii, p. 7, pl. ii, fig. 9 (*non cet.*).

The author's description of this species applies to the specimen (No. 144 S.A. Mus.) which he illustrated in his figure 7, having 4–6 ribs on each side of the sinus, and not precisely to that represented in his figure 6 (145 S.A. Mus.), which has more numerous ribs and other differences, so that the former must be taken as the type of the species, as Schwarz pointed out in 1906 (*op. cit.*, p. 368), though unfortunately (p. 375) he quotes all my figures under his further remarks on *Sp. Ceres.* The specimen which he figures (49 Alb. Mus.) is a good example of a brachial valve.

In 1908 Knod (*op. cit.*) considered that all the specimens which the author had referred to *Sp. Ceres* were probably identical with *Sp. Hawkinsi* Morris and Sharpe, from the Falkland Isles, and he regarded this species as a variety of *Sp. arrectus* Hall, and identical with *Sp. Quichua* D'Orb., in spite of Morris and Sharpe ‡ clearly

* Newton, Proc. Roy. Phys. Soc. Edinburgh, vol. xvi, p. 252, pl. x.

† Clarke, Mem. 9, New York State Mus., pt. 2, 1909, p. 82, pl. xix, figs. 5–12; pl. xx, figs. 6, 7.

‡ Morris and Sharpe, Proc. Geol. Soc., vol. ii, 1846, p. 276, pl. xi, figs. 1*a*, 1*b*.

stating that *Sp. Hawkinsi* had only 3 ribs on each side of the sinus, while the form to which Schwarz restricted the name *Ceres* and figured was regarded as another variety of *Sp. arrectus* and was allowed to retain the name *Ceres*. With this opinion the author cannot agree, and Clarke in 1913 (*op. cit.*) contested Knod's interpretation of the species, while he drew attention to its resemblance to *Sp. Iheringi* Kayser, a Brazilian species which Kayser established in 1900, but which Clarke * more fully described. Kozlowski (*op. cit.*) figured several shells under the name *Sp. arrectus* from Brazil, but only one resembles my *Sp. Ceres* as here restricted. The typical form comes from near Triangle (144, 149 S.A. Mus.). The broken specimen figured by me as *Reticularia* sp. shows 4–5 weak ribs on each side which are not represented in the figure, and it may probably be referred to *Sp. Ceres*.

Spirifer Ceres, Reed, var. *Iheringi* Kayser.

1900. *Spirifer Iheringi* Kayser, Rev. Mus. Paulista, vol. iv, p. 303, pl. i, fig. 2 ; pl. ii, fig. 3.

1903. *Spirifer ceres* Reed (pars), Ann. S. Afr. Mus., vol. iv, pt. 3, pl. xxii, fig. 6 (145 S.A. Mus.) (*non* fig. 7).

1908. *Spirifer arrectus* var. *Ceres* Knod, Neues Jahrb. f. Miner., Beil. Bd. xxv, p. 548, t. xxviii, fig. 4.

1913. *Spirifer Iheringi*, Clarke, "Foss. devon. Parana," p. 243, pl. xx, figs. 1–15 ; pl. xxi, figs. 11–13.

1913. *Spirifer arrectus* Kozlowski (pars), "Foss. devon. Brésil," Ann. Paléont., vol. viii, p. 7, pl. ii, figs. 6, 8.

The type of shell (No. 145 S.A. Mus.) from Slangfontein, which was figured by the author as belonging to *Sp. Ceres*, has more numerous and more angular ribs than the typical form of that species as correctly limited by Schwarz, and it seems comparable rather with *Sp. Iheringi* as described by Clarke from Brazil, though the latter seems to show a transition into the true *Sp. Ceres*. There are many specimens in the South African Museum and other collections which may be probably referred to or compared with *Sp. Iheringi* Kayser. This type of shell is especially abundant in the 1st Sandstone, east of Klein Straat Siding, and the casts show all the internal and external characters figured by Clarke (1087, 1095, 1096, 1097, S.A. Mus.). But we may doubt if this is a well-established species really separable from *Sp. Ceres*, and it may be only a variety. The whole question of the affinities

* Clarke, *op. cit.*, 1913, p. 243, pl. xx, figs. 1–15 ; pl. xxi, figs. 11–13.

or identity of the South African, South American, and North American species of *Spirifer*, and their relations to certain European Lower Devonian forms, is discussed at length by Clarke * in connection with his Brazilian material. In the latter he usually was able to distinguish the ornamentation of the shell and found it a valuable guide, whereas in the Bokkeveld collections we have almost invariably only poor casts or impressions to deal with, so that satisfactory conclusions are difficult to arrive at.

Spirifer euelpis sp. nov.

(Pl. V, fig. 1.)

? 1893. *Vitulina pustulosa* Ulrich (pars), Neues Jahrb. f. Miner. Geol., Beil. Bd. viii, t. iv, figs. 27, 29, ? 28.

1897. *Vitulina pustulosa* Kayser (pars), Zeitschr. deut. geol. Gesell., vol. xlix, p. 296, t. ix, figs. 11, 12 (*non cet.*).

1908. *Spirifer* sp. Reed, Ann. S. Afr. Mus., vol. iv, pt. 8, p. 400, pl. xlviii, fig. 4 (35 S.A. Mus.).

? 1908. *Spirifer planoconvexus* Knod, Neues Jahrb. f. Miner. Geol., Beil. Bd. xxv, p. 550, t. xxvii, figs. 10–12 (non *Spirifer planoconvexus* Shumard, 1872).

? 1913. *Spirifer planoconvexus* Clarke, "Foss. devon. Parana," p. 235.

Shell transversely triangular; cardinal angles acutely pointed at about 60°, with the anterior outline forming a continuous curve; hinge-line straight at greatest width of shell. Pedicle valve rather strongly convex; beak swollen, broad, incurved, pointed; median sinus narrow, scarcely wider than interpleural grooves; lateral lobes bearing 4–5 strong, simple, angular, or subangular prominent ribs on each side, of equal strength, straight or slightly curved back, separated by equally strong and wide angular or subangular grooves. Surface of shell ornamented with zigzag lines crossing grooves and ribs alike.

Dimensions (3820 S.A. Mus.) :—

Length . . .	11 mm.
Width . . .	19 mm.

Remarks.—There are two examples of the pedicle valve (3820, 3821 S.A. Mus.) of this shell in the South African Museum from Uitkomst, Ceres, as well as a brachial valve (35 S.A. Mus.) from Slangfontein which is probably attributable to it, though it was figured by me in 1908 as *Spirifer* sp. In shape and general characters this species much resembles *Sp. planoconvexus* Knod, from Bolivia, which Clarke

* Clarke, *op. cit.*, 1913, pp. 220–264.

thinks is the same as *Sp. plicatus* Weller,* from the Oriskany of New Jersey and elsewhere, though no zigzag lines on the surface are described by Knod. But we may especially compare *Sp. perlamellosus* Hall, from the Helderberg Formation of Maryland.† It seems that *Sp. Mischkei* Fuchs,‡ of the European Lower Devonian and *Sp. Mercuri* Gosselet from Lievin,§ are allied species.

We may suspect that some of the shells attributed by Ulrich and Kayser to *Vitulina pustulosa* belong to *Sp. planoconvexus* Knod, or to some allied species. Knod's name is preoccupied, though Shumard's shell is now usually referred to the genus *Ambocoelia,* and since there is some doubt as to the identity of our South African with the South American shell, we may designate it by the new name *euelpis.*

Meristella cf. *Riskowskii,* Ulrich.

(Pl. V, fig. 5.)

Shell subcircular. Pedicle valve convex, with weak longitudinal median sulcus ; beak low, rounded, obtuse, incurved, with rounded umbonal shoulders. Brachial valve convex, with short median internal septum about one-third the length of the valve. Surface of valves covered with a few strong concentric growth lamellae and finer growth-lines between them.

Dimensions (H. 64 Stell. Mus.): Length, *c.* 26 mm.; Width, *c.* 28 mm.

Remarks.—There is one crushed specimen (H. 64) in the Stellenbosch Museum in rather a poor state of preservation, but showing both valves as internal casts with their external impressions which may probably be referred to the Bolivian shell *Meristella Riskowski* Ulrich.‖ The specimen was found at Black's Farm, De Doorns, and it is the only Bokkeveld representative of this genus and species which I have seen. In the Lower Devonian of North America *M. champlaini* Clarke ¶ and *M. lata* Hall ** are allied species.

* Clarke, Mem. 9, New York State Mus., pt. 2, 1909, p. 181, pl. xxxi, figs. 1–17.

† Schuchert and Maynard, Maryland Geol. Surv., Lower Devonian, 1913, p. 397, pl. lxix, figs. 4–6.

‡ Dahmer, Jahrb. k. preuss. geol. Landesanst., Bd. 42, 1921, p. 280, t. ix, figs. 12–14.

§ Barrois and others, Mem. Soc. Geol. Nord, vol. vi, pt. 2, fasc. 2, 1920, p. 89, pl. xiii, fig. 11 ; pl. xvii, figs. 22–24.

‖ Ulrich, Neues Jahrb. f. Miner., Beil. Bd. viii, 1893, p. 64, t. iv, figs. 18*a–c*, 17, 18; Knod, *ibid.*, Beil. Bd. xxv, 1908, p. 551, t. xxviii, figs. 8, 8*a*.

¶ Clarke, Mem. 9, New York State Mus., pt. 1, 1908, p. 175, pl. xxx, figs. 1–20.

** *Ibid.*, p. 177, pl. xxx, figs. 21–26.

Cryptonella Baini (Sharpe).

1903. *Cryptonella Baini* Reed, Ann. S. Afr. Mus., vol. iv, pt. 3, p. 179, pl. xxii, figs. 1, 2 (133, 134 S.A. Mus.).

1908. *Cryptonella Baini* Knod, Neues Jahrb. f. Miner., Beil. Bd. xxv, p. 558.

1913. *Cryptonella? Baini* Clarke, "Foss. devon. Parana," p. 208, pl. xvii, figs. 10–17.

The original specimens from the Warm Bokkeveld (Nos. 11324) are in the British Museum, and those which I figured in 1903 came from Laken Vlei, Ceres, where it is common. It is an abundant form in some other localities, and Clarke records it from Brazil, but doubts its reference to the genus *Cryptonella*, and suggests that it belongs to *Oriskania*. We may remark on its resemblance to the Lower Coblenzian *Dielasma rhenana* Drev.,* which its founder considered to be most closely allied to *Terebratula melonica* Barrande, now referred to the genus *Cryptonella*. The brachidium is still unknown. I have collected good examples from the roadside cutting north of De Doorns (135 S.A. Mus.), and have seen others from the Gydo Pass (477 S.A. Mus.), Koudeveld Berg, Geelbosch Laagte, and elsewhere (6704, 3930 S.A. Mus.).

Centronella cf. *derbyana* (Hartt).

1903. *Cryptonella* sp.? Reed, Ann. S. Afr. Mus., vol. iv, pt. 3, p. 180, pl. xxii, fig. 3 (132 S.A. Mus.).

The small subcarinate oval shell which was referred by me as perhaps a young individual of *Cryptonella Baini* must be separated from that species on account of its more elongated shape and subcarinate pedicle valve. We may probably compare it with *Terebratula derbyana* Hartt † from Brazil, and *Centronella glansfagea* Hall ‡ from the Oriskany. *Oriskania navicella* Hall and Clarke § bears a considerable resemblance. *Centronella Arcei* Ulr. || from Bolivia is less like our shell. There are examples of this Bokkeveld shell from

* Drevermann, "Fauna d. Untercoblenzschicht. von Oberstadtfeld," Palaeontographica, vol. xlix, pt. 2, 1902, p. 98, t. xii, figs. 7–10.

† Hartt and Rathbun, Bull. Buffalo Nat. Hist. Soc., vol. i, 1874, p. 236, pl. x, figs. 15, 17, 18–22, 24, 25.

‡ Clarke, Mem. 9, New York State Mus., pt. 1, 1908, p. 163, pl. xxv, figs. 1–4.

§ Hall and Clarke, Palaeont. New York, vol. viii, Brach. ii, 1894, p. 269, pl. lxxix, figs. 25–27, text-figs. 181–183.

|| Ulrich, Neues Jahrb. f. Miner. Geol., Beil. Bd. viii, 1893, p. 53, t. v, figs. 5–9.

Stinkfontein (424 Pret. Mus.) and Bavian's Kloof (467 Pret. Mus.) in the Pretoria Museum.

Leptocoelia flabellites (Conrad).

1903. *Leptocoelia flabellites* Reed, Ann. S. Afr. Mus., vol. iv, pt. 3, p. 189, pl. xxiii, fig. 10 (for earlier references).

1905. *Leptocoelia flabellites* Thomas, Zeitschr. deut. geol. Gesell., vol. lvii, p. 264, t. xiv, fig. 35.

1908. *Leptocoelia flabellites*, Knod, Neues Jahrb. f. Miner., Beil. Bd. xxv, p. 553.

1913. *Leptocoelia flabellites*, Clarke, "Foss. devon. Parana," p. 269, pl. xxii, figs. 13–32.

1913. *Leptocoelia flabellites* Kozlowski, Ann. Paléont., vol. viii, p. 9, pl. xii, figs. 1, 2.

1916. *Leptocoelia flabellites*, Williams and Breger, Prof. Paper 89 U.S. Geol. Surv., p. 120, pl. v, figs. 19–30.

This very abundant and variable species occurs in every collection, but, owing to different conditions of preservation, it is not always easy to identify, and local varieties seem to exist.

The original specimens from the Bokkeveld, called by Sharpe *Orthis palmata* Morris and Sharpe, are from the Cold Bokkeveld (11319, 11320, 11321 Brit. Mus.). It is probable that the so-called *Leptocoelia acutiplicata* (Conrad) which has been recorded from the Devonian of South America,* but is typically a North American species,† should be included under this name, and many of the South African specimens here referred to *L. flabellites* seem indistinguishable from those figured by Thomas‡ from Argentina as *L. acutiplicata*, and the one from the Andes figured by Douglas § as belonging to the same species. Clarke,|| however, will not allow that these South American shells belong to Conrad's species or genus, and he removes them to the genus *Atrypina*.

The small subcircular shells figured by Morris and Sharpe ¶ from the Falkland Islands as *Atrypa palmata*, and described as having 15–16 ribs, appear to agree completely with the Oriskany type of

* Knod, *op. cit.*, 1908, p. 553, t. xxvii, figs. 13, 14, and references.

† Kindle, Bull. 508, U.S. Geol. Surv., 1912, p. 84, pl. vi, figs. 1–15 and references.

‡ Thomas, *op. cit.*, 1905, p. 263, t. xiv, figs. 36, 37.

§ Douglas, Quart. Journ. Geol. Soc., vol. lxx, 1914, p. 39, pl. viii, fig. 4.

|| Clarke, *op. cit.*, 1913, p. 348.

¶ Morris and Sharpe, Quart. Journ. Geol. Soc., vol. ii, 1846, p. 276, pl. x, figs. 3*a–d*.

L. flabellites (Conr.)* and with certain of the Bokkeveld specimens (248, 249 Cape Univ.); the shape and relatively larger teeth, and cardinal process and more numerous ribs, distinguish them from the transversely subquadrate or semi-elliptical shells with fewer (8–12) ribs (*e.g.* 3923 S.A. Mus.) which correspond with *Orthis aymara* Salter † from Bolivia. In spite of most authors regarding them as synonyms, it is probable that they mark distinct varieties, if not species. The references to the synonymy prior to 1903 were given by the author in his paper of that year, and consequently are not here repeated, though only accepted with the foregoing reservations.

Coelospira conjungens sp. nov.

(Pl. IV, fig. 14.)

Shell transversely semi-elliptical; cardinal angles rounded; hinge-line straight, slightly less than width of shell. Pedicle valve gently convex; beak small, pointed, slightly elevated; surface of valve with a rather broader median rib and 4–6 nearly straight, simple, broad, low, subangular ribs on each side, successively decreasing in prominence and strength to the cardinal angles, and separated by interspaces as wide as the ribs. Dental plates short, thin. Shell coarsely and densely punctate.

Dimensions (3895 S.A. Mus.) :—

Length . . .	10 mm.
Width . . .	13 mm.

Remarks.—This species is based on one good internal cast of a pedicle valve (3895 S.A. Mus.) from Hottentot's Kraal, Ceres. At first sight it might seem to be referable to the variable *Leptocoelia flabellites*, but the ribs are not angular, the shell is not subcircular, and the whole appearance is dissimilar. It appears to belong to the genus *Coelospira*, and to be allied to *C. concava* Hall, and especially to *C. camilla* Hall,‡ of the Oriskany and Upper Helderberg, which Schuchert § puts in the genus *Anoplotheca*, to which genus he refers all American species of *Leptocoelia* and *Coelospira*. Williams and Breger,|| however, separate the three genera.

* Hall and Clarke, Palaeont. New York, vol. viii, Brach. ii, 1894, p. 136, pl. liii, figs. 40–46, 53.

† Salter, Quart. Journ. Geol. Soc., vol. xvii, 1861, p. 68, pl. iv, fig. 14.

‡ Hall, Palaeont. New York, vol. iv, 1867, p. 329, pl. lii, figs. 13–19.

§ Schuchert, Bull. 87, U.S. Geol. Surv., 1897, p. 144.

|| Williams and Breger, Prof. Paper 89, U.S. Geol. Surv., 1916, p. 119.

Vitulina pustulosa Hall ?

1903. *Vitulina pustulosa* Reed, Ann. S. Afr. Mus., vol. iv, pt. 3, p. 191, pl. xxiii, fig. 11 (131 S.A. Mus.) (for earlier references).
1905. *Vitulina pustulosa* Thomas, Zeitschr. deut. geol. Gesell., vol. lvii, p. 267, t. xiv, fig. 43.
1907. *Vitulina pustulosa ?* "Courty, Explor. Géol. Amér. Sud," Mission Scient. G. de Crequi Montfort, Paris, pl. vi, figs. 11, 12.
1908. *Vitulina pustulosa,* Knod, Neues Jahrb. f. Miner., Beil. Bd. xxv, p. 554, t. xxvii, fig. 15.
1913. *Vitulina pustulosa,* Kozlowski, Ann. Paléont., vol. viii, p. 8.
1923. *Vitulina pustulosa* Kozlowski, *ibid.*, vol. xii, p. 96, pl. ix, figs. 26, 27.

Clarke * considers that the Argentine shells described by Thomas (*op. cit.*) as *Vit. pustulosa* are dorsal valves of *Atrypina*, and that most of Kayser's specimens figured in 1897 from the same country are small specimens of *Lepto. flabellites.* No true examples of *Vit. pustulosa* in South America had been observed by Clarke when he published his Brazilian memoir in 1913, and he also stated that my Bokkeveld shell was certainly not a *Vitulina*, and he held the same view with regard to Knod's Bolivian specimens. Whether such a sweeping statement is justified may be questioned, but at any rate some of Ulrich's † and of Kayser's ‡ figured specimens from Bolivia and Argentina respectively seem indistinguishable from the shell in the Bokkeveld Beds described by me above as *Spirifer euelpis.*

Ambocoelia pseudo-umbonata, Kozlowski.

1903. *Ambocoelia umbonata* Reed, Ann. S. Afr. Mus., vol. iv, pt. 3, p. 186, pl. xxiii, fig. 5 (130 S.A. Mus.).
1908. *Ambocoelia umbonata* Knod, Neues Jahrb. f. Miner., Beil. Bd. xxv, p. 551.
1913. *Ambocoelia pseudo-umbonata* Kozlowski, Ann. de Paléont., vol. xii, p. 95, pl. ix, figs. 1–9.

The South African shell which was described by the author in 1903 as *Ambocoelia umbonata* on the strength of two pedicle valves is found to be rather abundantly represented, and the additional specimens

* Clarke, "Foss. devon. Parana," 1913, pp. 83, 350.

† Ulrich, Neues Jahrb. f. Miner., Beil. Bd. viii, 1893, t. iv, fig. 29 (? 28).

‡ Kayser, Zeitschr, deut. geol. Gesell., vol. xlix, 1897, p. 296, t. ix, figs. 11, 12 (*non cet.*).

allow us to identify the species rather with the South American form described by Kozlowski (*op. cit.*) as *A. pseudo-umbonata* than with the typical North American form, as Kozlowski himself suspected, though it may be questioned if it should be separated only as a variety. Clarke * himself had expressed a doubt as to the identity of the two forms. But *A. umbonata* is somewhat variable.†

There is a fine large specimen (319) of a pedicle valve from the Gydo Pass in the collection of the Cape University measuring about 20 mm. in width and 12 mm. in length.

Rensselaeria montaguensis, Reed.

1908. *Rensselaeria montaguensis* Reed, Ann. S. Afr. Mus., vol. iv, pt. 8, p. 401, pl. xlviii, figs. 5, 6 (1610 S.A. Mus.) [*non* fig. 7].
1908. *Rensselaeria* aff. *Stewarti ?* Reed, *ibid.*, p. 403 (30, 21*a* S.A. Mus.).

This species was considered by the author in 1908 to resemble *R. atlantica* Clarke ‡ from the Chapman Sandstone (Lower Devonian) of Maine, and we may here note that it is more closely allied to *R. mainensis* Williams and Breger § from the same formation. Indeed it may be identical with it. *R. Stewarti* Clarke ‖ from the Dalhousie beds may also be compared, and it is almost certain that the specimens in the South African Museum from the Gydo Pass and Ladismith (30, 21*a* S.A. Mus.), and one from the Gydo Pass (82) in the Sedgwick Museum which the author regarded as probably allied to *R. Stewarti*, may be referred to *R. montaguensis*. A good internal cast of a complete shell from Uniondale (606 S.A. Mus.) in the South African Museum shows the internal characters clearly. Kegel ¶ put *R. atlantica* in the same group as *R. ovoides* Hall, to which therefore belongs the Bolivian *R. Knodi* Clarke.** But *R. falklandica* Clarke †† seems more closely allied to the Bokkeveld species.

* Clarke, "Foss. devon. Parana," 1913, pp. 76, 81.

† Kindle, Bull. 508, U.S. Geol. Surv., 1912, p. 83.

‡ Clarke, Mem. 9, New York State Mus., pt. 2, 1909, p. 79, pl. xxix, figs. 1–18.

§ Williams and Breger, Prof. Paper 89, U.S. Geol. Surv., 1916, p. 72, pt. xi, figs. 1–15.

‖ Clarke, *op. cit.*, 1909, p. 38, pl. vii, figs. 10–20 (? p. 79, pl. xviii, figs. 1–3).

¶ Kegel, "Der Taunusquartzit von Katzenelnbogen," Abh. k. preuss. geol. Landesanst., N.F., Heft 76, 1913, pp. 121–139.

** Clarke, "Foss. devon. Parana," 1913, p. 268; Kozlowski, *op. cit.*, 1923, p. 91, pl. x, fig. 19.

†† Clarke, *op. cit.*, 1913, p. 267, pl. xvii, figs. 29–31.

Rensselaeria relicta, Schwarz.

1903. *Trigeria* aff. *Gaudryi* Reed, Ann. S. Afr. Mus., vol. iv, pt. 3, p. 178, pl. xxi, figs. 11, 12 (150, 151 S.A. Mus.).

? 1903. *Rensselaeria* sp. *a*, Reed, *ibid.*, p. 176, pl. xxi, fig. 8 (149 S.A. Mus.).

1906. *Rensselaeria relicta* Schwarz, Rec. Albany Mus., vol. i, pt. 6, p. 364, pl. vii, fig. 7 (93 Alb. Mus.).

The question of the separation of *Trigeria* Bayle, from *Rensselaeria* Hall, and the taxonomic value of these groups has been discussed by Kegel,* but he has only dealt with the European and North American forms. He is led to regard *Trigeria* as only a subgenus of *Rensselaeria*, and if this is accepted we may, with much probability, refer Schwarz's species to it. *R. relicta* was described as almost circular, but it is wider than long and the figure is not quite satisfactory. The hinge-plate is massive and thick, probably owing to age, and is bilobed anteriorly with a short median groove on it ; the bases of the crura are seen on its front edge, and a low, short, thick median septum extends forwards between the rather deeply sunk, well-defined subtriangular muscle-scars which are in contact along their shorter inner sides and embrace in front a faint semi-elliptical area longitudinally striated, probably representing the anterior adductor scars. A few large pits are present on the genital areas on each side. The number of ribs is about 30–40, and is rather more than in the shell which the author, in 1903, compared with *Trigeria gaudryi* Oehl., and the hinge-plate is more massive, but the two agree in shape and general characters and are probably referable to the same species, though Kegel (*op. cit.*, p. 138) thought my *Trig. gaudryi* might be identical with my *Renss.* cf. *confluentina.*

Rensselaeria rotunda Reed.

1906. *Rensselaeria* cf. *confluentina* Reed, Geol. Mag., Dec. v, vol. iii, p. 308, pl. xvi, fig. 6 (605 S.A. Mus.) (=*R. rotunda* nom. prop.).

The name *rotunda* was suggested by the author in 1906 for the specimen (605 Cape Mus.) from the Gouritz River which was compared with Fuchs' European species *R. confluentina*. The view which Kegel †

* Kegel, " Der Taunusquartzit von Katzenelnbogen," Abh. k. preuss. geol. Landesanst., N.F., Heft 76, 1913, pp. 121–139.

† Kegel, *op. cit.*, p. 138.

adopted that it might be identical with the Bokkeveld shell previously described as *Trigeria* aff. *Gaudryi* * does not seem correct, but it may be allied to *Renss. falklandica* Clarke.† A good specimen of *R. rotunda* from Stinkfontein, Ceres, has been recognised in the Pretoria Museum (449 Pret. Mus.). We may probably compare with it the coarsely ribbed *R. diania* Clarke ‡ from the Moose River Sandstone of Maine, a species which is very similar to the European *R. crassicosta* Koch.

It may be mentioned that Dienst § considers the true *R. confluentina* Fuchs to be a synonym of *Trigeria gaudryi* Oehlert.

Trigeria gydoensis nom. prop.

1903. *Rensselaeria* sp. *β*, Reed, Ann. S. Afr. Mus., vol. iv, pt. 3, p. 177, pl. xxi, fig. 9 (156 S.A. Mus.).

? 1903. *Retzia* cf. *Adrieni*, Reed, *ibid.*, p. 187, pl. xxiii, fig. 6 (153 S.A. Mus.), fig. 7 (138 S.A. Mus.).

? 1906. *Rensselaeria* sp. *β*, Schwarz, Rec. Albany Mus., vol. i, pt. 6, p. 365 (2602 Alb. Mus.).

Schwarz thought it unfortunate that this " well-marked species " had not received a name, and we may accordingly suggest the name *gydoensis*, as the original specimen (156 S.A. Mus.) came from the Gydo Pass. It is probable that the external cast (138 S.A. Mus.) from Uitkomst, figured by the author as *Retzia* cf. *Adrieni*, should also be assigned to this species. With regard to its generic position we may perhaps refer this so-called *Rensselaeria* sp. *β* to the genus *Trigeria*, on the strength of its resemblance in shape and external characters to *Trigeria lepida* (Hall) || from the Hamilton Group. It does not seem referable to the genus *Brazilia* Clarke,¶ for that genus has no median sinus or fold, and at any rate we cannot see any trace of a similar loop in the interior. So far as they are known, the internal characters of our Bokkeveld shell appear to be more like *Trigeria* and *Rensselaeria* (which, as above stated, are not generically separated by Kegel). Schwarz's specimen (2602 Alb. Mus.) from Boschluis Kloof appears to be distinct from my type.

* Reed, Ann. S. Afr. Mus., vol. iv, pt. 3, 1903, p. 178, pl. xxi, figs. 11, 12.

† Clarke, *op. cit.* 1913, p. 267, pl. xvii, figs. 29–31.

‡ Clarke, Mem. 9, New York State Mus., pt. 2, 1909, p. 80, pl. xviii, figs. 4–6.

§ Dienst, Jahrb. k. preuss. geol. Landesanst., vol. xxxiv, pt. 1, 1914, p. 588.

|| Hall, Palaeont. New York, vol. iv, 1867, p. 276, pl. xlv, figs. 1–6 ; Hall and Clarke, *ibid.*, vol. viii, pt. 2, pl. l, figs. 36–40.

¶ Clarke, *op. cit.*, 1913, p. 214, pl. xvii, figs. 18, 19.

Scaphiocoelia africana, Reed.

1906. *Scaphiocoelia? africana* Reed, Geol. Mag., Dec. v, vol. iii, p. 306, pl. xvii, figs. 1–3*a* (607, 609 S.A. Mus.).

? 1908. *Rensselaeria montaguensis* Reed (pars), Ann. S. Afr. Mus., vol. iv, pt. 8, pl. xlviii, fig. 7 (1612 S.A. Mus.) (*non* figs. 5, 6).

1908. *Scaphiocoelia africana*, Reed, *ibid.*, p. 403, pl. xlviii, fig. 9 (1173 S.A. Mus.).

Since the author established this species in 1906 Knod * and Kozlowski † have given us considerable details of the internal characters of the closely allied form *Sc. boliviensis* Whitfield from the corresponding beds in South America. The last-mentioned author remarks that it seems closely allied to the South African species. More specimens (426 Pret. Mus.) which have been examined by me throw no further light on the characters of the species. But the generic reference can no longer be doubted. One of the shells (1612 S.A. Mus.) which was figured as *Renss. montaguensis* by the author in 1908 should apparently be placed in this species, and it is possible that the impression of a brachial valve (152 S.A. Mus.) which the author described in 1903 as *Rensselaeria* sp. ? ‡ from an unknown locality, having a peculiar grooving of the ribs near the beak, which has not been observed in any other specimen, may also belong to *Sc. africana.*

Scaphiocoelia africana, var. *elizabethae*, Reed.

1908. *Scaphiocoelia? africana* var. *elizabethae* Reed, Ann. S. Afr. Mus., vol. iv, pt. 8, p. 404, pl. xlviii, figs. 10–14 (1173*a*, 1175, 1176 S.A. Mus.).

Since this variety was described no further material has come under my notice, but Kozlowski (*op. cit.*, 1923, p. 93) remarks that it is referable to the same genus as the Bolivian species *Sc. boliviensis*, and, like *Sc. africana*, seems allied to it. Knod's figure of the interior of the brachial valve of this South American species (Knod, *op. cit.*, 1908, pl. xxix, fig. 4) seems to agree closely with the characters seen in our specimens.

Derbyina hottentot (Schwarz).

1906. *Rensselaeria hottentot* Schwarz, Rec. Albany Mus., vol. i, pt. 6, p. 365, pl. vii, fig. 8 (2578 Alb. Mus.).

The specimen on which Schwarz founded this species is an internal

* Knod, Neues Jahrb. f. Miner., Beil. Bd. xxv, 1908, p. 555, t. xxix, figs. 1–5.

† Kozlowski, Ann. de Paléont., vol. xii, 1923, p. 91, pl. x, fig. 20, text-fig. 6.

‡ Reed, Ann. S. Afr. Mus., vol. iv, pt. 3, p. 178, pl. xxi, fig. 10 (152 S.A. Mus.).

(not an external) cast of a brachial valve from Hottentot's Kloof, Ceres. As he remarked, the central rib is broader than the rest and is furrowed, just as in *D. Smithi*, and there are 6–7 narrower ribs on each side. The punctation, which is an important character, is distinct, and there are fine concentric striae over the surface also. The umbonal characters are not well preserved. Schwarz's figure is hardly satisfactory, and makes the shell too oval in shape. It is undoubtedly closely allied to *D. whitiorum* var. *africana* described below, but it seems to have fewer ribs. *D. Smithi* (Derby),* from the Brazilian Devonian, has, on the other hand, fewer and broader ribs than *D. hottentot*, and they are only distinctly developed near the margins.

Derbyina simplex (Schwarz).

1906. *Trigeria simplex*, Schwarz (pars), Rec. Albany Mus., vol. i, pt. 6, p. 366, pl. vii, fig. 9 (2589 Alb. Mus.).
1908. *Rhynchospira ? simplex* Reed, Ann. S. Afr. Mus., vol. iv, pt. 8, p. 400.

This species was founded on the internal cast of a brachial valve (2589 Alb. Mus.) from the Gydo Pass ; it is transversely subcircular in shape, with a short median fold arising at about one-third the length of the shell from the beak, and having a more prominent narrower rib on each side of it than the other 7–8 low rounded lateral ones, which are themselves narrower than the median one, and successively decrease in size. There are 15–17 ribs in all, not 21 as Schwarz described.

The shells from Montagu (79 Alb. Mus.) which he ascribed to this species show certain differences which incline me to remove them from association with it, but the form is too imperfectly known for a satisfactory determination. Some similar shells from the Steytlerville district occur on a slab (105) in the Port Elizabeth Museum.

The relations of *D. simplex* seem to be with *D. Smithi* and *D. hottentot* rather than with my *Trigeria* cf. *Gaudryi*, as Schwarz believed. For the latter shell may be referred without much doubt to Schwarz's *Rensselaeria relicta*.

Derbyina variegata (Reed).

1906. *Ptychospira variegata* Reed, Geol. Mag., Dec. v, vol. iii, p. 309, pl. xvi, fig. 7 (788 S.A. Mus.).

The specimen which the author described in 1906 as *Ptychospira*

* Clarke, *op. cit.*, 1913, p. 217, pl. xvii, figs. 20, 26.

variegata must be referred to the genus *Derbyina,* and it closely resembles *D. Smithi,* except in the number and size of the ribs, which are broader and number only 3–5 on each side of the median one. The locality, Hottentot's Kraal, has yielded a considerable number of specimens (3889, 3895 S.A. Mus.) (400 Pret. Mus.), but the locality of the type is unknown. We may remark on its close similarity in shape and ribbing to *Coelospira ? colona* Clarke * from Brazil, but the latter is described as possessing no punctae which are conspicuous in *D. variegata,* and Clarke himself (*op. cit.*, p. 82) has expressed the opinion that the latter is probably congeneric with *D. Smithi* (Derby).

Derbyina whitiorum, Clarke, var. nov. *africana.*

(Pl. V, figs. 2, 3.)

? 1903. *Rhynchospira* cf. *Silveti* (Ulrich) Reed, Ann. S. Afr. Mus., vol. iv, pt. 3, p. 188, pl. xxiii, fig. 8 (153 S.A. Mus.).

Shell plano-convex to bi-convex, subcircular. Pedicle valve moderately convex, subcarinate ; beak moderate, pointed, incurved ; surface of valve covered with 16–20 low, rounded, simple ribs, 8–10 being placed on each side of a narrow median sulcus, successively decreasing in size and strength to the cardinal angles, and separated by grooves narrower than the median sulcus ; dental plates thin, short, subparallel, with short muscle-scars lying between them. Brachial valve subcircular, gently convex or flattened ; surface with 8–10 similar ribs on each side of a rather broader median one, occasionally somewhat sunken. Internal median septum present, extending about two-fifths the length of the valve. Shell densely punctate.

Dimensions (3884 S.A. Mus.) :—

Length of pedicle valve . .	11·0 mm.
Width ,, ,, . . .	11·5 ,,

Remarks.—This small species is rather abundant in the coarse sandstone of Hottentot's Kraal, Ceres (3884, 3389, 3808, 3890, 3891 S.A. Mus.) (458, 421, 436, 434 Pret. Mus.), and occurs at Ezelfontein, Ceres (48 Cape Univ.), but is rarely well preserved. One pedicle valve (3884) and one brachial valve (3389) show the ribbing distinctly, but the surface is generally worn and the ribs are faint. It is very closely allied to *D. whitiorum* Clarke † from Brazil, but the pedicle valve of our variety seems more subcarinate.

* Clarke, *op. cit.*, 1913, p. 275, pl. xxii, figs. 8–12.

† *Ibid.*, p. 218, pl. xxii, figs. 1–7.

There is in the British Museum the best preserved internal cast of a brachial valve of this shell (B. 45500) which I have seen; it is labelled "*Atrypa* sp., Gydow Pass," and it seems to have belonged to the original Bain collection. It shows all the characteristic features of our species with considerable distinctness. It is probable that the small shell (153 S.A. Mus.) from Gydo Pass, Ceres, which the author in 1903 compared with Ulrich's *Rhynchospira* [*Centronella*] *Silveti*, may also be referred to this variety of *D. whitiorum*. The indistinct fossil (96 S.A. Mus.) from Gamka Poort, which the author * believed was a lamellibranch, and doubtfully referred to *Praecardium*, seems to be a distorted specimen of a *Derbyina* of much the same character.

Some of the Bokkeveld specimens here included, especially those from Klein Straat Siding (1084, 1089 S.A. Mus.), seem particularly to resemble *Retzia wardiana* Hartt and Rathbun,† and so does the shell figured by Schwarz ‡ as *Trigeria Silveti* (Ulr.), but they are not well enough preserved for exact determination; and the median sulcus on the pedicle valve seems no larger or deeper than the grooves between the lateral ribs.

Rhynchonella (*Clarkeia*) *Bodenbenderi* (Kayser).

(Pl. IV, fig. 6.)

1897. *Liorhynchus Bodenbenderi*, Kayser, Zeitschr. deut. geol. Gesell., Bd. xlix, p. 292, t. viii, figs. 1–10.
1905. *Liorhynchus Bodenbenderi*, Thomas (pars), *ibid.*, Bd. lvii, p. 265, t. xiv, figs. 31, 32 (*non* figs. 33, 34).
1913. *Liorhynchus* [*Clintonella*] *Bodenbenderi* Clarke, "Foss. devon. Parana," pp. 341–345, text-figs. 1–5.
1923. *Clarkeia antisiensis* Kozlowski, "Faune Dev. Bolivie," Ann. Paléont., vol. xii, p. 86, pl. ix, figs. 18–23, text-fig. 5 (1–4).

One internal cast of the brachial valve of a rhynchonelloid shell with a less perfect impression of its exterior was collected by me at Ezelfontein, and it agrees well with specimens of *Liorhynchus Bodenbenderi* as figured by Kayser and Thomas from the Argentine Devonian. The valve in our specimen is suboval in shape, but rather longer than wide, flattened in the middle, but descending steeply on the postero-

* Reed, Ann. S. Afr. Mus., vol. iv, pt. 6, 1904, p. 255, pl. xxxi, fig. 7.

† Hartt and Rathbun, Bull. Buffalo Nat. Hist. Soc., vol. i, 1874, p. 245, pl. x, figs. 2–5, 8, 9, 11, 12, 14.

‡ Schwarz, Rec. Alb. Mus., vol. i, pt. 6, 1906, p. 367, pl. vii, figs. 10*a*–*c* (2127 Alb. Mus.).

lateral margins ; the centre of the valve is occupied by a group of 4 equally strong, angular, straight ribs, extending from the beak to the margin, and forming a flattened low fold which is only definitely elevated at its front end ; the 2 middle ribs of the 4 are straight and parallel ; on each side of this group are 6 rather smaller, but similar, ribs, curving slightly outwards and forming the lateral lobes of the shell, but the 5th rib is weak and the 6th nearly obsolete. A median septum extends internally for half the length of the valve, arising from the hinge-plate where there is also a peculiar cardinal process (not well preserved) ; the crura are rather long and diverge at an angle of about 45° from the median line. The surface of the shell seems to be finely granulated. Clarke (*op. cit.*) considered that *L. Bodenbenderi* could be safely placed in the Silurian genus *Clintonella*, but Kozlowski identifies the species with *Terebratula antisiensis* D'Orb., and makes a new genus, *Clarkeia*, for its reception.

Dimensions :—

Length . .	17 mm.
Width . .	16 mm.

Retzia ? Thomasi sp. nov.

(Pl. V, fig. 4.)

? 1903. *Rhynchospira* cf. *Silveti* Reed (pars), Ann. S. Afr. Mus., vol. iv, pt. 3, p. 188, pl. xxiii, fig. 9 (131 S.A. Mus.) (*non* fig. 8).

Shell subcircular. Pedicle valve gently convex, with prominent, pointed, slightly incurved beak, the umbonal edges straight, extending nearly half the length of the shell, diverging at about 80°–90°. Surface of valve ornamented with about 18 straight, simple, rounded, or slightly subangular ribs of equal size, separated by grooves of equal or subequal width, all covered with delicate, close, concentric striae. Shell substance minutely punctate ? Dental plates short, strong, diverging at small angle.

Dimensions :—

Length . .	11 mm.
Width . .	11 mm.

Remarks.—The well-preserved specimen of this shell, collected by the author from the roadside cutting, near Buffelskraal, north of De Doorns, bears a close resemblance to the figure of one * of the shells

* Thomas, Zeitschr. deut. geol. Gesell., vol. lvii, 1905, p. 265, t. xiv, fig. 33 (*non cet.*).

from Argentina, ascribed by Thomas to *Liorhynchus Bodenbenderi* Kayser, though it is completely different from the type, and we may well doubt its specific identity in spite of the great variability of this species. There is no sign of any median sinus or group of larger ribs, and Thomas (*op. cit.*) states that this is also the case in his young individuals of *L. Bodenbenderi.* But it is difficult to see how such a shell can develop into the coarsely ribbed elongate sinuated form of the adult, with much fewer plications and a blunt low beak to the pedicle valve. At any rate it is safer to separate our Bokkeveld shell from these dubious representatives of *L. Bodenbenderi* Kayser, and we may distinguish it by the name *Thomasi.* But it may belong to a completely different genus such as *Retzia.* Hartt and Rathbun * figure a shell from Ereré as *Stenocisma dotis* Hall, which looks rather like it, and Knod † identifies a Bolivian brachiopod with this species. The imperfect specimen (131 S.A. Mus.) which the author in 1903 figured as *Rhynchospira* cf. *Silveti* Ulr., from the Warm Bokkeveld (*op. cit.*), may well be ascribed to the same species as our De Doorns specimen.

Incertae sedis.

1. It is very doubtful if the fragmentary shell from Gamka Poort (221 S.A. Mus.) which the present author described in 1903 as *Rhynchonella* (*Camarotoechia ?*) sp.‡ was correctly assigned to this genus, and it is at any rate too poor for satisfactory determination.

2. The fragmentary brachiopod which the author figured and described as *Orthis ?* sp. in 1903 § is of doubtful reference, and it is possible that the genus has been mistaken.

3. The impression of a large oval shell (6025 S.A. Mus.) from Uitenhage was figured and described by the author || in 1908 as *Rensselaeria* cf. *cayuga* Hall and Clarke, but a further examination of this unique and poor specimen confirms the occasional bifurcation and intercalation of the ribs (which are narrow and subangular), and therefore suggests that it cannot be referred to this genus in which the ribs are always simple and undivided, and we may more probably place it in some

* Hartt and Rathbun, Bull. Buffalo Soc. Nat. Hist., vol. i, 1874, p. 246, pl. viii, figs. 10, 12.

† Knod, Neues Jahrb. f. Miner. Geol., Beil. Bd. xxv, 1908, p. 552, t. xxvii, figs. 9, 9*a*.

‡ Reed, *op. cit.*, 1903, p. 175, pl. xxi, fig. 7.

§ Reed, *ibid.*, 1903, p. 175, pl. xxi, fig. 6.

|| *Ibid.*, vol. iv, pt. 8, 1908, p. 402, pl. xlviii, fig. 8.

genus such as *Hipparionyx*. But the specimen is in too unsatisfactory a condition for a precise comparison, and no other similar example has been observed.

4. The species *Tropidoleptus carinatus* Conrad has been recorded from South Africa * and from the corresponding beds in South America,† but the author is still doubtful of its occurrence in the Bokkeveld Beds, and Schwarz ‡ thinks that specimens of *Lept. flabellites* have been mistaken for it. In North America the species recurs on three distinct horizons in the Portage and Chemung Groups.§

LAMELLIBRANCHIATA.

Nuculites abbreviatus (Sharpe).

1856. *Cleidophorus abbreviatus*, Sharpe, Trans. Geol. Soc., ser. 2, vol. vii, p. 212, pl. xxvii, fig. 2 (11339 Brit. Mus.).

1904. *Nuculites abbreviatus* Reed, Ann. S. Afr. Mus., vol. iv, pt. 6, p. 256 (111 S.A. Mus.).

1904. *Nuculites* sp., Reed, *ibid.*, p. 261, pl. xxxii, fig. 3 (90 S.A. Mus.).

1908. *Nuculites abbreviatus* Reed, Ann. S. Afr. Mus., vol. iv, pt. 8, p. 388.

1908. *Nuculites martialis* Reed, *ibid.*, p. 389, pl. xlvii, fig. 10 (1599 S.A. Mus.) [non *N. martialis* Reed, 1904].

The type of this species (11339 Brit. Mus.) came from the Gydo Pass, but that described by me in 1904 was from Klein Straat Siding (111 S.A. Mus.), and others (1616, 1615 S.A. Mus.) have been recognised from the Zwartberg Pass. The crushed specimen (90 S.A. Mus.) from Gydo Pass to which I gave no specific name in 1904 may be referred to *N. abbreviatus*, and there are more specimens of this species from the same locality (5432, 5423 S.A. Mus.) in the South African Museum in a better state of preservation. The Zwartberg specimens show the teeth with distinctness ; the anterior teeth are thinner than the posterior ones, which are numerous and may number as many as 32. The shell from the Zwartberg Pass (1599 S.A. Mus.) which the author in 1908 figured as an example of *N. martialis* must be regarded as referable to *N. abbreviatus*, the curvature of the clavicular ridge and non-inflation of the shell agreeing with the last-mentioned species.

* Reed, Ann. S. Afr. Mus., vol. iv, pt. 3, 1903, p. 193.

† Kozlowski, " Faune Devon. Boliv.," Ann. Paléont., vol. xii, 1923, p. 85, pl. ix, fig. 28.

‡ Schwarz, Rec. Alb. Mus., vol. i, pt. 6, 1901, p. 367.

§ Williams, Prof. Paper 79, U.S. Geol. Surv. (1913).

A revised definition of the genus *Nuculites* Conrad was given by H. S. Williams * in 1917, the type being *N. oblongatus* Conr. But in 1916 Williams and Breger † preferred to use the generic term *Cleidophorus* Hall, 1847.

Nuculites africanus (Sharpe).

1856. *Cleidophorus africanus*, Salter M. S., Sharpe, Trans. Geol. Soc., ser. 2, vol. vii, p. 211, pl. xxvii, figs. 2 (11337 Brit. Mus.) and 2 (11338 Brit. Mus.).

1904. *Nuculites africanus* Reed, Ann. S. Afr. Mus., vol. iv, pt. 6, p. 256 (104 Cape Mus.).

? 1906. *Nuculites* cf. *Smithi* Reed, Geol. Mag., Dec. v, vol. iii, p. 303.

The first specimen figured by Sharpe of this species (11337 Brit. Mus.) is from the Gydo Pass, the second (11338 Brit. Mus.) is from the Cederberg. Both are poor and doubtfully belong to the same species. As previously mentioned, *N. Beneckei* Ulr. and *N. Smithi* Cl. seem to be allied.

I have seen a large number of specimens in the South African Museum and elsewhere which are referable to the same species. But the precise characters by which Sharpe meant to establish this species are rather uncertain, as the type specimens are so poor, and his definition is too general and indefinite.

Nuculites cf. *Beneckei* Ulrich.

? 1856. *Leptodomus ? ovatus* Sharpe, Trans. Geol. Soc., ser. 2, vol. vii, p. 212, pl. xxvii, fig. 7 (11342 Brit. Mus.).

? 1904. *Nuculites ? ovatus* Reed, Ann. S. Afr. Mus., vol. iv, pt. 6, p. 259.

1908. *Nuculites Beneckei*, var. Reed, Ann. S. Afr. Mus., vol. iv, pt. 8, p. 388, pl. xlvii, fig. 9 (1181 S.A. Mus.).

The triangular shape of this shell with narrowed posterior end and long sloping posterior dorsal margin seems to be more like Ulrich's *N. Beneckei* than any of the other described species, though the variety of *N. Sharpei* which I have here termed *remota* approaches it. Other specimens from the original locality, the Zwartberg Pass (1622, 14 S.A. Mus.), occur in the South African Museum. It is probable that Sharpe's *Leptodomus ? ovatus* from Leo Hoek (11342 Brit. Mus.) should be

* H. S. Williams, Proc. U.S. State Mus., vol. liv, No. 2225, 1917, p. 29.

† Williams and Breger, Prof. Paper 89, U.S. Geol. Surv., 1916, p. 159.

referred to this species, but no internal characters are visible in the solitary type specimen.

Nuculites capensis, Reed.

1904. *Nuculites capensis* Reed, Ann. S. Afr. Mus., vol. iv, pt. 6, p. 259, pl. xxxi, figs. 9, 9*a* (93 S.A. Mus.).

1908. *Nuculites capensis* Knod, Neues Jahrb. f. Miner., Beil. Bd. xxv, p. 525, t. xxiv, fig. 11.

The difference between this species from Gamka Poort and *N. oblongatus* Conr. has been pointed out by the author. The obliquity of the clavicular ridge does not seem due to distortion. Knod (*op. cit.*) has recognised *N. capensis* in the Devonian of Bolivia.

Nuculites obtusus, Reed.

1904. *Nuculites Branneri* Reed, Ann. S. Afr. Mus., vol. iv, pt. 6, p. 257, pl. xxxi, figs. 8, 8*a* (97 S.A. Mus.).

1908. *Nuculites Branneri* var. *obtusa*, Reed, *ibid.*, vol. iv, pt. 8, p. 389.

? 1913. *Nuculites pacatus* Clarke (pars), "Foss. devon. Parana," p. 179, pl. x, figs. 20–23 (*non* fig. 19).

? 1923. *Nuculites pacatus* Kozlowski, Ann. Paléont., vol. xii, p. 78, pl. viii, figs. 1, 1*a*, 2–4.

Clarke (*op. cit.*, 1913) does not think that the South African shell from Gamka Poort, which I described as *N. Branneri* Clarke, is the same as the Amazonas shell on which the species was founded, but he is certainly mistaken in associating it with my *N. pacatus*. Most of the shells from Brazil which he figures under the latter name seem to belong to the same species as the Bokkeveld one which I called *N. Branneri* in 1904; but subsequently, in 1908, I pointed out that it had an oblong rather than subelliptical shape, with a broader, more obtuse, and subtruncate posterior end, a less obliquely sloping dorsal margin, and a stouter clavicular ridge. For these reasons I removed it into a variety which I termed *obtusa*. Probably we may regard it as a definite species, for it seems to differ sufficiently from *N. Branneri* and to be a widely spread common form. Knod * recognised the species *N. Branneri* in the Devonian of Bolivia, but gave no figure. Williams and Breger † consider that *N. Branneri* is much like their *Cleidophorus perovalis* from the Chapman Sandstone of Maine.

* Knod, Neues Jahrb. f. Miner., Beil. Bd. xxv, 1908, p. 524.

† Williams and Breger, *op. cit.*, p. 161, pl. xxv, figs. 2, 10.

Nuculites oblongatus, Conrad.

(Pl. V, fig. 6.)

1923. *Nuculites oblongatus* Kozlowski, Ann. Paléont., vol. xii, p. 77, pl. viii, figs. 5*a*, *b* (and references).

This species has been described by Kozlowski from the Devonian of Bolivia, and it is represented in the Bokkeveld Beds by a specimen (1623 S.A. Mus.) from the Zwartberg Pass. It is chiefly distinguishable from *N. capensis* Reed by its vertical clavicular ridge and the shorter length of the shell. Beushausen * considers that the European species *N.* [*Cucullella*] *ellipticus* Maurer, from the Lower Devonian of Germany, is quite closely allied to *N. oblongatus*.

Our specimen (1623) shows well the group of longer teeth under the beak at the upper end of the clavicular ridge, and the much longer series of smaller posterior teeth extending nearly to the posterior end. There is another good example of this species from Ezelfontein in the Sedgwick Museum.

Nuculites martialis, Reed.

1904. *Nuculites martialis* Reed, Ann. S. Afr. Mus., vol. iv, pt. 6, p. 260, pl. xxxii, fig. 2 (103 S.A. Mus.).

Non 1908. *Nuculites martialis* Reed, *ibid.*, vol. iv, pt. 8, p. 389, pl. xlvii, fig. 10.

Though this species seems to present distinctive characters, I am rather doubtful if it is well established, for the type shell from Ezelfontein is somewhat broken, and I have not seen any other examples which can be referred to the same species, while the shell from the Zwartberg Pass (1599 S.A. Mus.) described under this name in 1908 must be considered referable to *N. abbreviatus* (see page 68).

Nuculites pacatus, Reed.

1908. *Nuculites pacatus*, Reed, Ann. S. Afr. Mus., vol. iv, pt. 8, p. 390, pl. xlvii, figs. 5, 5*a*, 6 (794 S.A. Mus. and 12 Vict. Coll.).

1913. *Nuculites pacatus* Clarke (pars), "Foss. devon. Parana," p. 179, pl. x, fig. 19 (*non* figs. 20–23).

The points of difference between *N. pacatus* and the South African shells referred to *N. Branneri* by me in 1904 were mentioned when the species was described, but it may be re-stated that *N. pacatus* differs

* Beushausen, Abh. k. preuss. geol. Landesanst., N.F., Heft 17, 1895, p. 105, t. v, figs. 9–15.

from *N. Branneri* by its more elongated oval shape, more inflated valves, more subequal and less truncate ends, lower beaks, stronger, thicker, and shorter clavicular ridge, and less oblique dorsal margin. Clarke * and Kozlowski † put both these South African types of shells under the specific name *pacatus*, and as such describe examples from the Devonian of Brazil and Bolivia. But I cannot agree that they should be combined under one specific name, and an examination of further Bokkeveld specimens shows that the above-mentioned points of difference are constant, though in imperfectly preserved shells they may not all be invariably recognisable. It does not seem that any of Kozlowski's figured shells are referable to *N. pacatus* sens. str., and the same applies to all but one of Clarke's Brazilian specimens.

A fine example of *N. pacatus* was collected by the author at Ezelfontein showing the dentition and all the typical characters of the species.

Nuculites Sharpei, Reed.

1908. *Nuculites Sharpei* Reed, Ann. S. Afr. Mus., vol. iv, pt. 8, p. 391, pl. xlvii, figs. 7, 8 (18, 19 S.A. Mus.).
1913. *Nuculites Sharpei* Clarke, "Foss. devon. Parana," p. 181, pl. x, figs. 7, 8 (*non* figs. 9–14).

This species was established for a well-defined type of shell in the Bokkeveld Beds from Ezelfontein, Ceres, and it seems to be represented in Brazil, but, judging from Clarke's figures, not all his specimens which he represents can be attributed strictly to it, for they are too short and oval ; these I would remove into a new variety (see below).

Nuculites Sharpei, Reed, var. nov. *remota*.

(Pl. V, fig. 7.)

1908. *Nuculites Branneri*, Reed (pars), Ann. S. Afr. Mus., vol. iv, pt. 8, p. 389 (796, 797 S.A. Mus.).
1913. *Nuculites Sharpei* Clarke (pars), "Foss. devon. Parana," p. 181, pl. x, figs. 9, 10, 13, 14 ? (*non* figs. 7, 8).

Shell elongate-oval, narrowing posteriorly ; beak obtuse, situated at one-fourth length of valve ; anterior end broadly rounded, short ; posterior end sharply rounded, narrower ; hinge-line straight, with a series of 20–25 postumbonal very small transverse teeth reaching

* Clarke, *op. cit.*, 1913, p. 179.
† Kozlowski, Ann. Paléont., vol. xii, 1923, p. 78, pl. viii, figs. 1, 1*a*, 2–4.

about three-fourths its length, and 8–9 longer subumbonal teeth at top of clavicular ridge, which is long, vertical, and extending nearly three-fourths the height of shell. Surface of valve very slightly convex.

Dimensions (796 S.A. Mus.) :—

Length	. .	35 mm.
Height	. .	24 mm.

Remarks.—This variety is less elongate than the typical *N. Sharpei*, and some examples from an unknown locality were erroneously ascribed to *N. Branneri* by the author in 1908, but were not figured. In the collection of the University of Cape Town there is a cast and impression of a left valve (129 *a*, *b*) which may be attributed to this variety, but it has four strong regular equidistant growth-ridges on the surface as Clarke represents (*op. cit.*, fig. 9) in one of his specimens of *N. Sharpei* from Ponta Grossa, though such ridges are not commonly developed in the species ; the inferior margin is also more strongly arched than usual. The specimen measures 34 mm. in length and about 23 mm. in height, but the beak is broken off.

Nuculites (*Ditichia*) *colonicus* Reed.

1904. *Nuculites colonicus* Reed, Ann. S. Afr. Mus., vol. iv, pt. 6, p. 259, pl. xxxii, fig. 1 (69 S.A. Mus.).

The presence of two internal septa in the valve in this species suggests that it should be referred to the genus or subgenus *Ditichia*, Sandberger, 1891,* and it appears to be allied to *Nuculites* (*Ditichia*) *doto* Clarke † of the Oriskany fauna of Highland Mills, Orange Co., New York.

Palaeoneilo antiqua (Sharpe).

1856. *Solenella antiqua* Sharpe, Trans. Geol. Soc., ser. 2, vol. vii, p. 210, pl. xxvii, fig. 1 (52056, I. 14848, 14849 Brit. Mus.).

1904. *Palaeoneilo antiqua* Reed, Ann. S. Afr. Mus., vol. iv, pt. 6, p. 261.

It is not probable that Clarke's *Pal. magnifica* ‡ from Brazil is identical with Sharpe's species, for the dentition is different, but my

* Sandberger, Neues Jahrb. f. Miner. Geol., 1891, vol. ii, p. 104 ; Williams and Breger, Prof. Paper 89, U.S. Geol. Surv., 1916, p. 168.

† Clarke, Mem. 9, New York State Mus., pt. 2, 1909, p. 140, pl. xxxiii, figs. 5–10.

‡ Clarke, *op. cit.*, 1913, p. 176, pl. xii, figs. 9–12.

Pal. subantiqua is closely allied, and both may be specifically inseparable from *Pal. sancti-crucis* Clarke,* but the latter varies much in shape, judging from Clarke's figures.

Williams and Breger † restrict the use of the name *Palaeoneilo* Hall to forms of the type of *P. constricta* (Conrad), using the name *Tellinites* M'Coy for such species as *P. Orbignyi* and *P. Boyesi*. But the present author prefers to follow the usage of Clarke (*op. cit.*).

Palaeoneilo arcuata (Schwarz).

1906. *Palaeoneilo arcuata*, Schwarz, Rec. Albany Mus., vol. i, pt. 6, p. 378, pl. viii, fig. 5 (103 Alb. Mus.).

? 1913. *Palaeoneilo sancti-crucis* Clarke (pars) "Foss. devon. Parana," p. 177, pl. xi, fig. 14 (*non cet.*).

This species is much like the elongated example of *Pal. sancti-crucis* Clarke as figured by him from Brazil, though the umbonal ridge which usually causes the angulation of the posterior margin in that species is hardly noticeable in that example, and cannot be called strong. The more oval elongated almond shape is characteristic of *P. arcuata*. The original example of this species was collected at Hottentot's Kloof, Ceres, and there is another specimen (3866 S.A. Mus.) from this locality in the South African Museum. Schwarz believed that this species might eventually be found referable to the genus *Leda* [=*Nuculana*], but no evidence of this is available.

Palaeoneilo rudis (Sharpe).

1856. *Solenella rudis* Sharpe, Trans. Geol. Soc., ser. 2, vol. vii, p. 211, pl. xxvii, fig. 6 (11341 Brit. Mus.).

1904. *Palaeoneilo rudis* Reed, Ann. S. Afr. Mus., vol. iv, pt. 6, p. 261.

1906. *Palaeoneilo Boyesi* Schwarz, Rec. Albany Mus., vol. i, pt. 6, p. 377, pl. viii, fig. 1 (86 Alb. Mus.).

1908. *Palaeoneilo rudis* Reed, Ann. S. Afr. Mus., vol. iv, pt. 8, p. 392.

The type of this species (11341 Brit. Mus.) has the umbonal ridge less marked than Sharpe's figure (*op. cit.*) would lead us to conclude, and the umbonal sulcus is scarcely apparent. The coarse concentric ridges and lamellae are well seen. This specimen is from Hottentot's

* Clarke, *op. cit.*, 1913, p. 177, pl. xii, figs. 13–16.

† Williams and Breger, *op. cit.*, 1916, pp. 163, 168.

Kloof, and so are the other specimens (14847, 11356, 11355, 52051, 14846 Brit. Mus.) in the same collection.

The type of Schwarz's species, *P. Boyesi* (86 Alb. Mus.), is from the same locality and so is his paratype (87 Alb. Mus.), and many other specimens in the Albany Museum, while certain shells in the South African Museum (Nos. 3844, 800, 3878, 3837, 3873), likewise from the same locality, possess precisely the same features. Schwarz states that his species differs from *P. rudis* in its more prominent umbo and longer anterior portion, but an examination of his type in the Albany Museum, and of Sharpe's *P. rudis* in the British Museum, convinces me that they are inseparable, and, therefore, Schwarz's name must be dropped. Williams and Breger * compare *P. Boyesi* with *Tellinites* (*Koenenia*) *gibbosa* Goldf. var. *Kayseri* Beush. from the Chapman Sandstone, and consider the latter identical with *Pal. Orbignyi* Clarke of the Devonian of Brazil; but with this comparison the author does not agree. The European Lower Devonian shell described as *Ctenodonta unioniformis* Sandb.† appears to be more allied to *P. rudis*.

Palaeoneïlo Orbignyi, Clarke.
(Pl. VI, figs. 6, 8.)

1899. *Palaeoneïlo Orbignyi* Clarke, Archiv Mus. Nac. Rio de Janeiro, vol. x, p. 74, pl. viii, figs. 14–17.

In the collection of the University of Cape Town there is one large specimen of a right valve (77) of a species of *Palaeoneilo* contained in a nodule from Ezelfontein, Ceres, and differing from *P. rudis* by its more central beak and more equal anterior and posterior ends. It has been labelled *P. Boyesi* Schwarz, and is in the condition of an internal cast. The shell is transversely oval, the inferior margin being more arched than in *P. rudis*; the beak is broad and subcentral, and the whole valve is most swollen in the umbonal region. From the beak there is rather a marked low fold running down the posterior slope to the inferior margin, curving gently backwards; behind it is a flattened wide shallow sulcus with faint traces of one or two lower broader radial folds running back to the upper part of the posterior margin; and there are two similar weak folds running forwards from the beak on the upper anterior slope to the anterior margin. Behind the beak we can see about 20 short small equal transverse

* Williams and Breger, *op. cit.*, 1916, p. 165.

† Beushausen, *op. cit.*, 1895, p. 84, t. vi, figs. 10–15.

teeth forming a series extending more than half the distance to the posterior end, while between and in front of the beaks there is a shorter series of +12 smaller transverse teeth; the anterior part of the hinge is broken away.

Dimensions (77 Cape Univ.): Length, 55·0 mm.; Height, 35·0 mm.; Distance of beak from anterior end, *c.* 25·0 mm.

From a comparison of the Bokkeveld specimen with the description and figures of Clarke's *P. Orbignyi* from Brazil, there can be but little doubt that we have here to do with an example of this species. A young specimen with less marked radial folds occurs in the South African Museum from Laken Vlei, Ceres (3791 S.A. Mus.).

Palaeoneilo Orbignyi Clarke; var. nov. *tenuilineata*.

(Pl. VI, figs. 7, 7*a*.)

Shell transversely subelliptical; valves moderately convex, somewhat compressed posteriorly; beaks low, obtuse, rounded, situated at about two-fifths the length from the front end; narrow weak sulcus subparallel to hinge-line and close to it running back from beaks to posterior margin, and a broader more marked one below it widening to postero-inferior angle (faintly developed or absent in small examples), with occasionally traces of a third shorter weaker sulcus below. Surface of valve covered with regular fine raised concentric thread-like lines of equal strength, closely placed and equidistant, but becoming rather finer and more numerous towards the beak.

Dimensions (128 Cape Univ.):—

Length . .	34 mm.
Height . .	22 mm.

Remarks.—This variety, which is represented by specimens (128 Cape Univ.) from Keurbosch, has rather a more elongated shape than the typical *Pal. Orbignyi*, Clarke,* except in the smaller examples (132 Cape Univ.), but the beak is too subcentral for *Pal. sancti-crucis*, or for any of the other species described above. The smaller examples seem not to have the sulci developed or they are only faintly indicated. The shell from the Chapman Sandstone which Williams and Breger †

* Clarke, Archiv Mus. Nac. Rio de Janeiro, vol. x, 1899, p. 74, pl. viii, figs. 14–17; *id.*, Mem. 9, New York State Mus., pt. 2, 1909, p. 109, pl. xxviii, figs. 20–23.

† Williams and Breger, *op. cit.*, p. 165, pl. xix, figs. 3, 9, 11, 13, 15, 16; pl. xxv, figs. 1, 3, 4, 5, 12.

described as *Tellinites* (*Koenenia*) *gibbosa* Goldf. var. *Kayseri* Beush., may also be compared. The regular concentric lineation is like that in *Pal. constricta* Hall * of the Hamilton Group.

Palaeoneilo sancti-crucis, Clarke.

1904. *Palaeoneilo* cf. *fecunda* Reed, Ann. S. Afr. Mus., vol. iv, pt. 6, p. 264, pl. xxxii, fig. 6 (3965 S.A. Mus.).
1913. *Palaeoneilo sancti-crucis* Clarke (pars) " Foss. devon. Parana," p. 177, pl. xi, figs. 13, 15 (*non* 14, 16).

According to Clarke's figures this species varies much in its shape, but, according to his description, it is " elongate, rather narrowly ovate, with subequal extremities, evenly convex, of relatively large size, suppressed umbones, a gentle double sinus on the postumbonal slope which emarginates the outline in a double curve," and he considers that my *P. subantiqua* has rather close affinities with it. But the elongate form of Clarke's species (*op. cit.*, fig. 14) is more like *P. arcuata* Schwarz, as above noticed. The shell which I compared with *P. fecunda* Hall, from Ezelfontein (3965 S.A. Mus.) appears to agree in all essentials with Clarke's fig. 13 of *P. sancti-crucis*, and some of the specimens from Hottentot's Kloof in the South African Museum may also be referable to this species. But it is difficult to separate imperfect or distorted shells of this type into species.

Palaeoneilo subantiqua, Reed.

1904. *Palaeoneilo subantiqua* Reed, Ann. S. Afr. Mus., vol. iv, pt. 6, p. 262, pl. xxxii, figs. 4, 4*a* (85 S.A. Mus.).
1908. *Ctenodonta* (*Palaeoneilo*) *subantiqua* Knod, Neues Jahrb. f. Miner., Beil. Bd. xxv, p. 524, t. xxiv, fig. 10.
? 1913. *Palaeoneilo sancti-crucis* Clarke (pars), " Foss. devon. Parana," p. 177, pl. xi, fig. 16 (*non* 13–15).

This species seems closely similar to some of Clarke's figured examples of *P. sancti-crucis*, but the latter is typically more elongate. *P. magnifica* Clarke † is also closely related. Knod (*op. cit.*) claims to have recognised *P. subantiqua* in Bolivia, but we cannot judge of the accuracy of this identification from his figure. All the South African and South American species of this genus have close affinities,

* Hall, Palaeont. New York, vol. v, pt. 2, 1885, p. 333, pl. xlviii, figs. 1–16.
† Clarke, *op. cit.*, 1913, p. 176, pl. xi, figs. 9–12 (especially fig. 10).

and it is difficult to distinguish the species, particularly when we are ignorant of their denticulation.

Palaeoneilo vindicata sp. nov.

(Pl. VI, figs. 11, 12.)

Shell transversely suboval, narrowing posteriorly, highest at umbones. Valves moderately convex, most so anteriorly. Umbones situated at about one-fourth (or less) the length of shell, directed forwards, with depressed concave lunule below; anterior end of shell rather sharply rounded below; inferior margin rather strongly arched; posterior end of shell narrowed, blunt, rounded; dorsal edge nearly straight, slightly oblique, sloping downwards to posterior end. Teeth transverse, forming short series of about 8 in front of umbones passing into series of 6–7 narrower radially arranged teeth between umbones, and thus into posterior series of 18–20, becoming rather larger posteriorly and continued to end of hinge-line. Muscular impressions very faint.

Dimensions :—

	Left Valve.	Right Valve.
Length . . .	12·5	17·0 mm.
Height . . .	8·0	10·0 mm.

Remarks.—There is one good internal cast of a left valve from De Doorns, collected by Dr. Rastall, and now in the Sedgwick Museum, from which the above description is drawn up. Another specimen from the same locality in the same collection is of the right valve of a rather larger individual, and is bored by *Clionolithus priscus* (M'Coy), just as Clarke * figures in the case of a Brazilian specimen of *Pal. magnifica* Clarke. The chief distinction between our new species and the others above described is the absence of any sinus on the postumbonal slope and the non-emargination of the posterior outline. Clarke † figures a specimen from Ponta Grossa as " believed to belong " to *Pal. rhysa* Clarke, but differing considerably from the type of this species (*op. cit.*, pl. xi, fig. 5); it resembles our species to a considerable extent, and more closely than does *Pal. elliptica* Kozl.‡ from Bolivia, which, however, is allied. The European species, *Ctenodonta primaeva* Stein.,§ which Beushausen puts in *Palaeoneilo*,

* Clarke, *op. cit.*, 1913, pl. xi, fig. 11. † *Ibid.*, p. 178, pl. xi, fig. 7 (*non* 5, 6).

‡ Kozlowski, *op. cit.*, 1923, p. 79, pl. viii, figs. 6–8.

§ Beushausen, Abh. k. preuss. geol. Landesanst., N.F., Heft xvii, 1895, p. 79, t. v, figs. 28–30.

may be compared, but especially the American species *P. plana* Hall,* from the Middle Devonian of Maryland.

Ctenodonta Grahami, Reed.

1925. *Ctenodonta Grahami* Reed, Rec. Albany Mus., vol. iii, pt. 4, p. 258, pl. x, figs. 1–3.

Shell suboval, transverse, moderately biconvex, most so in middle, somewhat compressed anteriorly. Beaks large, high, incurved, slightly directed backwards, subcentrally situated, rather nearer anterior than posterior end. Inferior margin forming regular gentle convex curve bending up rather suddenly at each end; anterior end rather blunter and more subtruncate than posterior end. Preumbonal lunule short, lanceolate, not extending more than half the length of preumbonal hinge-line. Postumbonal lunule larger, sublanceolate, extending about two-thirds length of postumbonal hinge-line.

Hinge-line obtusely angulated between beaks, and bearing numerous transverse teeth, the anterior series composed of a few (7–8) broad short teeth (only 3–4 are visible), the subumbonal series of several (? 10–12) longer, sharper, more closely-placed teeth (only 4–5 are exposed) passing into the posterior series of about 10 shorter broader teeth arranged in a slightly concave curve. Posterior muscle-scar large, deeply impressed; anterior muscle-scar subcircular, smaller.

Dimensions (81 Alb. Mus.): Length, 45 mm.; Height, 34 mm.; Thickness, 23 mm.

Remarks.—There is one complete internal cast (No. 81) in the Albany Museum in the Bain Collection from the Warm Bokkeveld, and it is a unique specimen.

Knod has described and figured a shell from the Lower Devonian of Bolivia as *Ctenodonta* (*Palaeoneilo*) *musculosa*,† which appears to bear a considerable resemblance to our shell, but he uses the generic name *Palaeoneilo* in a different sense to what Clarke and the author do. The shell from Bolivia, which Ulrich termed *Nucula Krügeri*,‡ may also be compared with our species.

* Prosser and Kindle, Maryland Geol. Surv., Mid. Devon. 1913, p. 237, pl. xxvi, figs. 13–15.

† Knod, Neues Jahrb. f. Miner., etc., Beil. Bd. xxv, 1908, p. 520, t. xxiv, figs. 3–6.

‡ Ulrich, *ibid.*, Beil. Bd. viii, 1893, p. 48, t. ii, fig. 18.

Ctenodonta Stowi sp. nov.

(Pl. V, figs. 8–10*a*.)

1904. *Palaeoneilo* aff. *constricta* Reed, Ann. S. Afr. Mus., vol. iv, pt. 6, p. 263, pl. xxxii, figs. 5, 5*a* (95 S.A. Mus.).

1904. *Palaeoneilo* sp. Reed, *ibid.*, p. 264, pl. xxxii, fig. 7 (96 S.A. Mus.).

Shell subtriangular, short, rounded, somewhat inflated; beaks subanterior, situated at about one-fourth the length of the shell, with the anterior and posterior umbonal slopes meeting at 90°–100°; anterior end of shell steeply descending, broadly rounded at lower angle; inferior margin strongly arched, with sharply rounded narrower posterior end. Hinge-line broadly angulated, with 5–8 teeth in front, several more slender subumbonal teeth and a gently arched post-umbonal series of 12–16 coarse, stout teeth, reaching back four-fifths the length of the shell. Valves moderately convex, deepest anteriorly, and somewhat truncated in front. Surface of shell ornamented with rather strong concentric lamellae.

Dimensions (7777 S.A. Mus.) :—

Length . . .	14·5 mm.
Height . . .	12·0 mm.

Remarks.—The two specimens (95, 96 S.A. Mus.) from Gamka Poort which were ascribed to *Palaeoneilo* by the author in 1904 were poor, but better ones (133*a*, 7777 S.A. Mus.) have now been examined in the South African Museum, obtained from between the 2nd and 3rd Sandstones, 300 yards from Triangle Station, and Dr. Rastall has obtained a perfect internal cast of a complete shell from De Doorns (now in the Sedgwick Museum), so that its reference to *Ctenodonta* is satisfactorily determined. It seems to be a species allied to *Ct. Maureri* Beush.* of the European Devonian, and probably to *Nucula corbuliformis* Hall † of the Hamilton Group of North America. The Brazilian species of *Nucula* described by Clarke ‡ from the Devonian of Para seem less closely related.

* Beushausen, Abh. k. preuss. geol. Landesanst., Heft 17, 1895, p. 85, t. vii, figs. 11–28.

† Hall, Palaeont. New York, vol. v, pt. 2, 1885, p. 319, pl. xlvi, figs. 24–34.

‡ Clarke, Archiv Mus. Nac. Rio de Janeiro, vol. x, 1899, p. 70.

Ctenodonta ? nigella (Reed).

1908. *Nucula nigella* Reed, Ann. S. Afr. Mus., vol. iv, pt. 8, p. 394, pl. xlvii, figs. 13, 13*a* (3946 S.A. Mus.).

It was suggested by me in 1908 that Sharpe's Bokkeveld species, *Leptodomus ? ovatus*, might belong to the same species as my *Nucula nigella* from the Zwartberg Pass, but there is only the external shape of the former by which to form any conclusion as to its generic position, and a further examination of the original specimen in the British Museum inclines me rather to ascribe it to *Nuculites*, and it is above mentioned in connection with *N. Beneckei*. However, our *N. nigella* appears to be closely allied to *N. Kayseri* Clarke,* from Para, and it may belong to the new subgenus *Nuculoidea* established by Williams and Breger † for certain Lower Devonian species from Maine.

Nuculana inornata (Sharpe).

1856. *Leda inornata* Sharpe, Trans. Geol. Soc., ser. 2, vol. vii, p. 212, pl. xxvii, fig. 5.
1904. *Leda inornata* Reed, Ann. S. Afr. Mus., vol. iv, pt. 6, p. 255.
1908. *Nuculana inornata* Reed, *ibid.*, vol. iv, pt. 8, p. 392.

The type of shell which Sharpe chose for this species is represented by several specimens (3845, 3968, 3865 S.A. Mus.) from the original locality, Hottentot's Kloof, and from Uitkomst (77*f* S.A. Mus.), in the South African Museum. But the shell which Clarke ‡ figured from Brazil under this name is not the same species, or at any rate is a distinct variety, being more like my *N. viator*,§ and this has caused some confusion. An examination of Sharpe's type specimen (11340 Brit. Mus.) in the British Museum has cleared up the uncertainty. *Leda* [*Nuculana*] *diversa* Hall, which Knod || considers as identical with Sharpe's species, has a much more rapidly tapering and more pointed posterior end, and the posterior upper margin is more concave, as is seen in Clarke's and Knod's figures.

* Clarke, *op. cit.*, 1899, p. 70, t. viii, figs. 1, 2.
† Williams and Breger, *op. cit.*, 1916, p. 173.
‡ Clarke, "Foss. devon. Parana," 1913, p. 184, pl. xi, figs. 1–4.
§ Reed, Ann. S. Afr. Mus., vol. iv, pt. 8, 1908, p. 393, pl. xlvii, figs. 11, 11*a*.
|| Knod, Neues Jahrb. f. Miner., Beil. Bd. xxv, 1908, p. 526, t. xxiv, fig. 1.

Nuculana viator, Reed.

1908. *Nuculana viator*, Reed, Ann. S. Afr. Mus., vol. iv, pt. 8, p. 393, pl. xlvii, figs. 11, 11*a*.

1913. *Nuculana inornata*, Clarke, "Foss. devon. Parana," p. 184, pl. xi, figs. 1–4.

The European species *N. securiformis* (Goldf.) * from the Coblenzian may be compared with this Bokkeveld species from the Zwartberg Pass, and it is certainly the case that the specimens from Brazil which Clarke attributed to *N. inornata* Sharpe have much more the appearance of *N. viator* owing to their shorter, more pointed posterior end, subcentral beaks, and concave posterior dorsal margin.

Leda diversa Hall, which Clarke † has figured from the Brazilian area is more closely allied with this species than with *N. inornata*, in spite of Knod holding the opposite opinion as above mentioned.

Leda sp. *a*, figured by Ulrich ‡ from Bolivia, may be identical with *N. viator*.

Nuculana ? agrestis, Reed.

1908. *Nuculana agrestis*, Reed, Ann. S. Afr. Mus., vol. iv, pt. 8, p. 393, pl. xlvii, figs. 12, 12*a*.

No further specimens of this species have been recognised in any of the collections, and there is nothing further to add to the original description.

Modiomorpha hexensis sp. nov.

(Pl. VI, figs. 1–3.)

Shell compressed, transversely oval, slightly oblique, widening a little posteriorly; valves very shallow, flattened; beak low, subanterior; anterior end of shell short, rounded; posterior end obliquely truncated above, with subacute postero-inferior angle; inferior margin slightly arched, nearly straight; hinge-line about two-thirds the length of the shell, straight, or weakly arcuate. Surface of valve crossed by low subangular umbonal ridge dying out posteriorly, the portion of the valve above it flattened and inclined at an obtuse angle to the lower portion. Anterior muscle-scar large subterminal, sharply-defined behind. Ornamentation of surface consisting of regular, coarse, equal, raised thread-like concentric lines, making a

* Beushausen, Abh. k. preuss. geol. Landesanst., N.F., Heft 17, 1895, p. 59, t. iv, figs. 26–28, ? 29; Barrois, Pruvost, and Leriche, Mém. Soc. Geol. Nord, vol. vi, pt. 2, 1920, p. 130, pl. xvi, fig. 12.

† Clarke, Archiv Mus. Nac. Rio de Janeiro, vol. x, 1899, p. 78, t. viii, fig. 12.

‡ Ulrich, *op. cit.*, 1893, p. 45, t. ii, fig. 14.

sharp bend on crossing the umbonal ridge and tending to be arranged in groups of 6–8 with wide grooves between the groups.

Dimensions :—

Length . . .	*c.* 62 mm.
Height (max.) . .	*c.* 28 mm.

Remarks.—The author collected specimens of this shell from the roadside cutting north of De Doorns, and there is a good specimen also (No. 280) from Keurbosch, Hex River district, in the collection of the Cape University. As regards its affinities it may be especially compared with the first figured specimen of *Modiomorpha pimentana* Clarke,* from Brazil, and it seems that *M. odiata* Clarke,† from the Moose River Sandstone, Maine, is also closely allied to it. But the angulation of the concentric lines on crossing the umbonal ridge is sharper in our species and more like *Goniophora ? cercurus* Clarke,‡ of the Oriskany of New York.

It was at first thought that this species might be attributed to the genus *Cypricardella*, and Clarke has figured a Brazilian shell as *C. ? olivieria*,§ which, but for the absence or obsolescence of the oblique umbonal ridge and the less sudden bending of the concentric lines on crossing it, bears a considerable resemblance, as do also some Chemung examples of *C. bellistriata* (Conr.) figured by Hall ‖ from New York. But in our specimens there is not the excavation of the preumbonal margin, and the beaks seem to be more anterior in position. The dentition also is unknown. Clarke himself was doubtful of the generic position of his *C. ? olivieria*, and remarked on its resemblance to a certain Bolivian shell referred by Knod ¶ to *Modiomorpha* cf. *pimentana* (Hartt and Rathbun).

Modiomorpha lunulata (Schwarz).

1906. *Nuculites lunulata* Schwarz, Rec. Albany Mus., vol. i, pt. 6, p. 378, pl. viii, figs. 6, 6*a* (135 Alb. Mus.).

The shell (135 Alb. Mus.) which Schwarz described as *Nuculites*

* Clarke, Archiv Mus. Nac. Rio de Janeiro, vol. x, 1899, p. 52, t. vi, fig. 4 (*non* 5–9).

† Clarke, Mem. 9, New York State Mus., pt. 2, 1909, p. 74, pl. xv, figs. 14, 15 (*non* pl. xvi, figs. 1–5).

‡ *Ibid.*, p. 141, pl. xxxiii, figs. 18–20.

§ Clarke, "Foss. devon. Parana," 1913, p. 198, pl. xvi, figs. 10, 11.

‖ Hall, Palaeont. New York, vol. v, pt. 2, 1885, p. 308, pl. lxxiv, figs. 5, 6 (*non cet.*).

¶ Knod, *op. cit.*, 1908, p. 527.

lunulata is certainly not referable to that genus, for the hinge-line shows no sign of transverse teeth, and the so-called clavicular ridge is merely the sharp posterior boundary of the anterior muscle-scar just as in the species *Modiomorpha odiata* Clarke,* from the Lower Devonian of Maine. The cardinal view which Schwarz gives (*op. cit.*, fig. 6*a*) shows also the characters of *Modiomorpha*, and the species may possibly be identical with *M. Helmreicheni* Clarke,† from the Devonian of Para.

Probably the largest shell of the three in the British Museum marked L. 5586, measuring about 40 mm. in length and 25 mm. in height towards its posterior end, from some unknown locality in South Africa, may be referred to the same species. It bears rather broad but low unequal and non-equidistant concentric rugae, as Schwarz shows in his figure of *M. lunulata*.

Modiomorpha montaguensis sp. nov.

(Pl. V, fig. 14.)

Shell obliquely oval, much compressed, highest posteriorly, with short straight hinge-line and obtuse posterior cardinal angle ; posterior margin gently arched, obliquely descending ; postero-inferior angle rather sharply rounded ; inferior margin nearly straight, oblique, passing up into sharply ascending, rounded, very short anterior margin, which projects below the beak. Beaks small, low, subanterior, with low but distinct gently curved umbonal ridge running back towards postero-inferior angle, but dying out posteriorly. Surface of shell covered with concentric growth-lines, some stronger than others, and all bending rather sharply on crossing the umbonal ridge.

Dimensions (Stell. Mus.) :—

Length (oblique)	*c.* 45 mm.
Height (at right angles to hinge-line)	*c.* 32 mm.

Remarks.—The one specimen on which this variety is founded consists of a nearly complete shell (with the right valve best preserved) in the Stellenbosch Museum. It was collected from the road between Montagu and Triangle. It is somewhat allied to the Brazilian *M. pimentana* (Hartt and Rathb.),‡ but seems higher posteriorly,

* Clarke, Bull. 107, New York State Mus., 1907, p. 218, text-fig. ; *id.*, Mem. 9, New York State Mus., pt. 2, 1909, p. 74, pl. xv, figs. 14, 15 ; pl. xvi, figs. 1–5.

† Clarke, Archiv Mus. Nac. Rio de Janeiro, vol. x, 1899, p. 50, t. vi, figs. 1, 2, 17.

‡ Clarke, *op. cit.*, 1899, p. 52, t. vi, figs. 4–9.

the axis being inclined at a larger angle (about 45°) to the hinge-line. Some specimens of *M. protea* Clarke * from the Lower Devonian of Maine seem to resemble it, and *M. aroostooki* Williams and Breger † is allied.

Modiomorpha nigra (Reed)

906. *Sanguinolites niger* Reed, Geol. Mag., Dec. v, vol. 3, p. 304, pl. xvi, figs. 4, 4*a* (625*b* S.A. Mus.).

It is probable that this species should be rather placed in some section of the genus *Modiomorpha* than in *Sanguinolites*, and it bears not a little resemblance to *M. Hermanni* Kegel ‡ from the Taunus Quartzite. It is also much like the Bolivian species *Modiomorpha? minuta* Kozl.,§ and Clarke's *Goniophora abbreviata* || from Brazil still more resembles our shell, but it is certainly not a member of *Goniophora* in the ordinary sense of the word. There is a well-preserved small specimen of a right valve showing the slightly oblique concentric striae on the surface from De Doorns in the Sedgwick Museum, and numerous internal casts occur in the Stellenbosch Museum from the road between Montagu and Triangle. Some of the figures of shells attributed to *Sphenotus truncatus* (Conr.) ¶ bear a considerable resemblance to our species, but the type form seems to be distinct.

Modiomorpha cf. *austronotica*, Clarke ?

1904. *Modiomorpha* aff. *Sellowi* Reed, Ann. S. Afr. Mus., vol. iv, pt. 6, p. 268, pl. xxxii, fig. 11 (122 S.A. Mus.).

The small shell (122 S.A. Mus.) from the top of Hottentot's Kloof, which the author considered allied to *Modiomorpha Sellowi* Clarke, may perhaps be compared with *M. austronotica* Clarke,** as it is more oval and more oblique than the former. *M. praecursor* Frech,†† from the Coblenzian of the Rhine, appears to be also related to our shell.

* Clarke, Mem. 9, New York State Mus., pt. 2, 1909, p. 107, pl. xxvi, figs. 4–8.

† Williams and Breger, *op. cit.*, 1916, p. 219, pl. xxi, figs. 2–7, 10–13.

‡ Kegel, Abh. k. preuss. geol. Landesanst., N.F., Heft 76, 1913, p. 68, t. iv, figs. 3*a*, *b*.

§ Kozlowski, *op. cit.*, 1923, p. 80, pl. viii, figs. 14, 14*a*, *b*.

|| Clarke, "Foss. devon. Parana," 1913, p. 198, pl. xvi, figs. 1, 2.

¶ Clarke, Mem. 9, New York State Mus., pt. 1, 1908, p. 232, pl. xxii, figs. 9, 10 (*non* figs. 11, 12).

** Clarke, *op. cit.*, 1913, p. 199, pl. xvii, figs. 5–8.

†† Drevermann, "Fauna d. Untercoblenzsch. von Oberstadtfeld," Palaeontographica, vol. xlix, pt. 2, 1902, p. 86, t. x, figs. 11–14.

Williams and Breger * think that *M. Sellowi* should be placed in the genus *Cypricardites* Conrad.

Modiomorpha cf. *scaphula* Clarke (pars) ?

There is one imperfect specimen of conjoint valves of a lamellibranch (245 Univ. Cape) in the Cape University collection which has the beak of the right valve partly preserved. In outline and general characters it seems to be comparable to the first figured example of *Modiomorpha ? scaphula* Clarke † from Ponta Grossa, but is quite unlike the other specimens (*op. cit.*, pl. xvii, figs. 1, 2) from Tybagy. Our shell has no obliquely transverse depression across the valves nor any umbonal ridge, the valves being gently convex and only somewhat flattened on the sides; the upper edge is broken as well as the subumbonal portion of the shell, but the concentric growth-lines and occasional stronger ridges show its general shape.

Dimensions :—

Length . . .	*c.* 41 mm.
Height . . .	25 mm.
Thickness . .	14 mm.

Modiomorpha (*Modiella ?*) sp.

(Pl. V, fig. 12.)

There is one nearly perfect internal cast of a lamellibranch in the Stellenbosch Museum which was collected from the road between Montagu and Triangle; the posterior end is broken and part of the inferior margin is imperfect. The general shape is obliquely elongate oval, widening posteriorly; the hinge-line is long and straight, and seems to have been at least three-fourths the length of the shell; the beaks are low, rounded, obtuse and subanterior, being close to the anterior end, which projects a little in front of them at the inferior angle; the inferior margin seems to have been nearly straight, but oblique. The shell is compressed anteriorly, and a broad shallow depression crosses the valve in the anterior part of the shell unusually far forward, and is bounded behind by a low rounded umbonal ridge which soon dies out posteriorly and merges into the general gentle convexity of the posterior part of the surface. The posterior end seems to have been broadly rounded, judging from the concentric lines on the surface. A weak oblique narrow groove runs back

* Williams and Breger, *op. cit.*, 1916, p. 155.

† Clarke, *op. cit.*, 1913, p. 199, pl. xvi, fig. 9 (*non* pl. xvii, figs. 1, 2, 3, 4).

behind the umbonal ridge to the posterior lower angle of the valve. The hinge-line shows the usual features. The surface is covered with concentric growth-striae, and there are distinct traces of low radial lines. In our specimen the right valve is alone well preserved. We may probably compare it with the shells from the Gaspé Sandstone of Quebec described and figured by Clarke as *Modiella modiola* Clarke,* and *Modiella pygmaea* (Conr.),† and with *Modiomorpha impar* Clarke ‡ from the Dalhousie Formation. There is also figured by Clarke a small shell from Ponta Grossa attributed to *Modiomorpha* § which bears a considerable resemblance to our specimen. It should be noted that *Modiella modiola* Clarke is not identical with the European *Modiomorpha modiola* Beushausen.

Janeia Baini (Sharpe).

1856. *Modiolopsis? Baini* Sharpe, Trans. Geol. Soc., ser. 2, vol. vii, p. 213, pl. xxvii, fig. 9 (11344 Brit. Mus.).
1904. *Modiomorpha Baini* Reed, Ann. S. Afr. Mus., vol. iv, pt. 6, p. 267.

The shorter and more oblong shell, the more truncate posterior end and more strongly-marked umbonal ridge, are characters which enable us to distinguish this species from the very closely-allied *Janeia braziliensis* Clarke. On the same slab (111 S.A. Mus.) as that holding the so-called *Glossites* aff. *depressus* (which is probably referable to *Jan. braziliensis*) there is an example of Sharpe's species, so that they can be directly compared and their differences observed. But they are undoubtedly very closely allied.

Janeia braziliensis, Clarke.
(Pl. V, figs. 13, 13*a*.)

? 1904. *Glossites* cf. *depressus*, Reed, Ann. S. Afr. Mus., vol. iv, pt. 6, p. 254, pl. xxxi, fig. 5 (111 S.A. Mus.).
1908. *Modiomorpha Baini* var. Reed, *ibid.*, vol. iv, pt. 8, p. 398.
1913. *Janeia braziliensis*, Clarke, "Foss. devon. Parana," p. 190, pl. xv, figs. 11–21.

A beautifully-preserved complete example of this species (5419 S.A. Mus.) occurs in the South African Museum, showing both valves

* Clarke, Mem. 9, New York State Mus., pt. 1, 1908, p. 232, pl. xxiii, figs. 1–5.
† *Ibid.*, p. 231, pl. xxiii, figs. 6, 7.
‡ *Ibid.*, pt. 2, 1909, p. 31, pl. vi, figs. 6–8.
§ Clarke, "Foss. devon. Parana," 1913, pl. xvi, fig. 4.

with the shell preserved. It was obtained at the Kamanassie River, Oudtshoorn, and measures 55 mm. in length, 31 mm. in height, and 19 mm. in thickness. It is without doubt closely allied to Sharpe's *Modiolopsis Baini*, but has a more elongate linguiform shape, a less truncate posterior end, and a less developed umbonal ridge.

With regard to the South African shell which was compared with *Glossites depressus* Hall, Clarke * questioned the correctness of my comparison and believed it was referable to the genus *Janeia*, and it is probable that this poor specimen should be referred to *J. braziliensis*, though *Glossites amnigenoides* Will. and Breg.† from the Chapman Sandstone bears a considerable resemblance to it.

Schwarz,‡ in 1906, referred a specimen of a lamellibranch from Ezelfontein, Ceres (2575 Alb. Mus.) to the Brazilian species *Cypricardella Pohli* Clarke,§ but it is in a very poor state of preservation, and as far as its characters are recognisable it may more probably be compared with *Jan. braziliensis*. Williams and Breger,|| however, think that *Cypricardella Pohli* may belong to the genus *Anodontopsis* M'Coy, and they see in this species a resemblance to their *A. maccoyiana* Will. and Breg.¶ from the Chapman Sandstone, Maine. The true relations and position of Schwarz's specimen cannot be satisfactorily determined.

Janeia bokkeveldensis (Reed).

1908. *Solenopsis? bokkeveldensis* Reed, Ann. S. Afr. Mus., vol. iv, pts. 8, 14, p. 397, pl. xlviii, fig. 1 (1607 S.A. Mus.).

? 1913. *Janeia bokkeveldensis* Clarke, "Foss. devon. Parana," p. 193, pl. xv, figs. 1–10.

Clarke (*op. cit.*) stated that he had little doubt of the identity of certain Brazilian shells with this South African species originally described from the Zwartberg Pass. Personally I am not so sure about the matter, and Clarke's figures show a considerable diversity in form and ornamentation. The fine radial granulated lines which are conspicuous below and in front of the oblique umbonal groove in our shell do not seem to be similarly or equally developed in the South American examples. The reference of the species to *Janeia* rather than to *Solenopsis* may, however, be accepted.

* Clarke, *op. cit.*, 1913, p. 81; Williams and Breger, *op. cit.*, 1916, p. 146.

† Williams and Breger, *op. cit.*, 1916, p. 145, pl. xix, fig. 20.

‡ Schwarz, Rec. Alb. Mus., vol. i, pt. 6, 1906, p. 380, pl. viii, fig. 3.

§ Clarke, Archiv Mus. Nac. Rio de Janeiro, vol. x, 1899, p. 64, pl. vi, fig. 10.

|| Williams and Breger, *op. cit.*, 1916, p. 238.

¶ *Ibid.*, p. 236, pl. xxiv, fig. 14; pl. xxvi, figs. 2, 3, 5–7, 10, 12, 13.

Janeia bokkeveldensis (Reed), var. *acer* (Reed).

1906. *Sanguinolites? acer* Reed, Geol. Mag., Dec. v, vol. iii, p. 305, pl. xvi, figs. 5, 5*a*, 5*b* (625*c* S.A. Mus.).

In the figure which was given by the author of this shell which was collected at the Zwartberg Pass, the oblique sulcus is rather too much emphasised, while the concentric lines and rugae were not drawn sufficiently oblique ; the valve was made too flattened and not convex enough in the side view, and the beak was represented as less obtuse than it should be. The presence of fine but distinct equidistant radial lines crossing the radial lines and thus producing small granules at their intersection was not noted.

The shell seems to be a short variety of *J. bokkeveldensis*, for the ornamentation of the surface, the oblique narrow sulcus, and the obtuse beak resemble this species very closely. The more pointed postero-inferior angle shown in my original figure seems due to the upper posterior margin being imperfect, the course of the concentric lines and rugae giving the true shape of the shell. Knod * has figured a Bolivian shell as *Sphenotus Bodenbenderi*, showing radial lines on the surface ; but the reference of our specimen from the Zwartberg Pass to *Janeia* can hardly be doubted.

Grammysia (*Grammysioidea*) *corrugata* (Sharpe).

1856. *Sanguinolites? corrugatus* Sharpe, Trans. Geol. Soc., ser. 2, vol. vii, p. 212, pl. xxvii, fig. 8 (11343, 14850 Brit. Mus.).

1904. *Grammysia corrugata* Reed, Ann. S. Afr. Mus., vol. iv, pt. 6, p. 253.

1906. *Nyassa arguta?* Reed, Geol. Mag., Dec. v, vol. iii, p. 303, pl. xvi, figs. 3, 3*a*.

1908. *Nyassa arguta* Reed, Ann. S. Afr. Mus., vol. iv, pt. 8, p. 398.

Cf. 1913. *Macrodon?* sp. Clarke, "Foss. devon. Parana," p. 184, pl. xvi, fig. 8.

After a further examination of Sharpe's type in the British Museum and a comparison with the shells which I referred to *Nyassa arguta* Hall, in 1906–8, it seems practically certain that they are identical. Sharpe's figure does not make the beaks sufficiently obtuse and rounded, nor the valves sufficiently swollen and sinuated.

A fairly well-preserved specimen, probably referable to the same species, was collected by Dr. Rastall at De Doorns and is now in the

* Knod, *op. cit.*, 1908, p. 529, t. xxv, fig. 5 (*non* 6, 7).

Sedgwick Museum; it measures about 30 mm. in length and about 18 mm. in height at the beak. It is noticeable that Clarke's figures of *Modiomorpha? scaphula* * from Tybagy, Brazil (but not those from Ponta Grossa), seem to represent a very similar shell, but at any rate I believe our Bokkeveld shell is referable to *Grammysia* (*Grammysioidea*).†

Grammysia (*Grammysioidea*) *fontinalis* (Reed).

1908. *Leptodomus? fontinalis* Reed, Ann. S. Afr. Mus., vol. iv, pt. 8, p. 395, pl. xlvii, figs. 14, 14*a* (183*a* S.A. Mus.).

The resemblance of this species is very close to *Grammysia Lundi* Clarke,‡ and it may be identical with it or with *Gr. Gardneri* Clarke,§ also from Brazil, both of which seem to belong to the same subgenus *Grammysioidea*. There is so much confusion about the use of the name *Leptodomus* ‖ that it is better not to apply it to this species, which does not seem to fit in with the revised and restricted definition of this genus.

Grammysia (*Grammysioidea*) *montana* Reed.

1908. *Grammysia montana* Reed, Ann. S. Afr. Mus., vol. iv, pt. 8, p. 395, pl. xlviii, fig. 2 (1805 S.A. Mus.).

As the author pointed out, this species is closely allied to *Grammysia Lundi* Clarke, which Williams and Breger ¶ put in their new subgenus *Grammysioidea*, comprising a group of shells which are particularly abundant in the Lower Devonian.

Grammysia (*Grammysioidea*) *campestris* (Reed).

1904. *Cardiomorpha campestris* Reed, Ann. S. Afr. Mus., vol. iv, pts. 6, 11, p. 254, pl. xxxi, fig. 6 (102 S.A. Mus.).

? 1923. *Grammysia rara* Kozlowski, Ann. Paléont., vol. xii, p. 76, pl. x, figs. 14, 14*a*.

The shell described and figured from Bolivia by Kozlowski under the name *Grammysia rara* sp. nov. seems almost inseparable from the

* Clarke, *op. cit.*, 1913, p. 199, pl. xvii, figs. 1, 2 (*non* 3, 4).

† Williams and Breger, *op. cit.*, 1916, p. 134.

‡ Clarke, Archiv Mus. Nac. Rio de Janeiro, vol. x, 1899, p. 66, t. vi, figs. 11–13.

§ *Ibid.*, p. 67, t. vii, fig. 10.

‖ Williams and Breger, *op. cit.*, 1916, p. 130.

¶ *Ibid.*, p. 134.

Ezelfontein specimen which the author named *Cardiomorpha campestris*. The short subquadrate form, the position and size of the beaks, the somewhat inflated valves with a short hinge-line and other characters appear to agree in every detail. Probably the species should be placed in the genus or subgenus *Grammysioidea* and be compared with *Gr. Lundi* Clarke and *Gr. fontinalis* Reed, rather than with any species of *Cardiomorpha*.

Grammysia (*Grammysioidea*) *scaphuloides* sp. nov.

(Pl. VI, figs. 4, 5.)

1904. *Grammysia* sp. Reed, Ann. S. Afr. Mus., vol. iv, pt. 6, p. 252, pl. xxxi, fig. 3 (214 S.A. Mus.).

Shell transversely subelliptical to subquadrate, widening a little posteriorly, inflated. Beaks broad, obtuse, swollen, rounded, incurved, subanterior, situated at about one-fourth (or less) the length of the shell and rising above the hinge-line. Anterior end of valves sharply rounded, meeting hinge-line at rounded angle ; inferior margin gently arched, long ; posterior end obtuse, broadly rounded, meeting hinge at obtuse angle ; hinge-line straight, about two-thirds the length of shell. Surface of valves swollen, convex, rounded, without sulcus or umbonal ridge, ornamented with a few (6–7) strong, subequal, coarse, overlapping, slightly oblique concentric lamellae, set at subequal distances apart, with fine concentric striae between them.

Dimensions :—

	(72 Univ. Cape.)	(192 S.A. Mus.)
Length of shell . .	48 mm.	*c*. 34 mm.
Height ,, at beak .	32 ,,	*c*. 22 ,,

Remarks.—There is a good specimen of a right valve in the collection of the Cape University (No. 72) from Ezelfontein, Ceres, and a poorer one (192 [6708] S.A. Mus.) of another right valve somewhat crushed from Riet Vallei, E.N.E. of Ceres, in the South African Museum. The oblique sulcus across the surface of the latter seems due to an injury, and the description of the species is drawn up from the other specimen. It much resembles *Gr. fontinalis*, but the less anterior beak, straight and longer hinge-line and strong concentric lamination, distinguish it. In outline and breadth of beak at about one-fourth the length of the hinge-line it resembles an unnamed species of *Grammysia* figured by Knod * from Bolivia. The coarse lamellation of

* Knod, *op. cit.*, 1908, p. 529, t. xxv, fig. 10.

the surface recalls *Gr. corrugata* (Sharpe) which is undoubtedly allied, but can hardly be regarded as identical.

There is an imperfect and crushed more subquadrate specimen (197 S.A. Mus.) from Riet Vallei, E.N.E. of Ceres, which has the anterior part of the left valve well preserved with the shell still attached and shows the coarse concentric lamellae and finer intermediate concentric lines very distinctly. The outline of this specimen differs somewhat from the type, but this is apparently due to its crushed condition. The same remark applies to the specimen (214 S.A. Mus.) from Ezelfontein, Ceres, figured by the author in 1904 (*op. cit.*) as *Grammysia* sp. Traces of fine radial striae are visible in one specimen (110 Univ. Cape) from between Montagu and Triangle which closely resembles in this respect, as it does in general shape and position of the beak, the shells from Tybagy, Brazil, figured by Clarke * as *Modiomorpha? scaphula*, but all our specimens are quite unlike the first figured example of this species (*op. cit.*, pl. xvi, fig. 9), which has much less coarse concentric lamination and a less obtuse and less incurved beak as well as no transverse broad oblique depression.

Goniophora gydoensis sp. nov.

(Pl. V, fig. 11.)

Shell very elongated, sublanceolate, acutely pointed posteriorly; inferior margin very gently arched; hinge-line straight, about half length of shell, subparallel to inferior margin; posterior end of shell obliquely truncate, gently arched, making angles of about 130° with hinge-line, and of about 45° with inferior margin; anterior end narrow (not well preserved). Beaks subterminal. Valves deep, traversed by strongly raised angular umbonal ridge running from beak to acute postero-inferior angle, rising to maximum height at about one-third the length of the shell; surface of valves flattened above and to a less extent below umbonal ridge, and marked with thick regular raised thread-like concentric lines of equal strength, sharply bent back on crossing the umbonal ridge.

Dimensions (5436 S.A. Mus.):—

Length	*c.* 35 mm.
Height at posterior end of hinge-line .	14 mm.

Remarks.—There is only one specimen (a left valve) of this new species from Gydo Pass, Ceres, but it is in a good state of preservation

* Clarke, *op. cit.*, 1913, p. 199, pl. xvii, figs. 1, 2 (*non* 3, 4); (*non* pl. xvi, fig. 9).

with the exception of the anterior end. It seems more allied to the European species *Goniophora acuta* Sandb.,* *G. nassoviensis* Kayser,† and *G. kilmoriensis* Reed,‡ than to any South American species. But *G. hamiltonensis* § Hall, of the Middle Devonian of New York and Maryland, bears a great resemblance to it. A discussion of the characteristics and limitations of the genus is given by Williams and Breger, and they state that it attains the acme of its development in the Lower Devonian.||

Goniophora ? sp.

1904. *Modiomorpha* cf. *pimentana* Reed, Ann. S. Afr. Mus., vol. iv, pt. 6, p. 268, pl. xxxii, fig. 10 (146 S.A. Mus.).

The specimen which was compared by the author in 1904 with *Modiomorpha pimentana* Hartt and Rathbun ¶ appears on further examination to be more probably referable to some species of *Goniophora,* and some of the shells which Clarke ** described from the Moose River Sandstone, Maine, as *Cardiomorpha* (*Goniophora*)*? simplex* bear a considerable resemblance. But certain European species of *Sphenotus,* such as *Sph. elongatus* Spriest.†† and *Sph. carinatus* Spriest.,‡‡ have much the same external appearance, and the generic reference must remain somewhat doubtful.

Sanguinolites albanus, Reed.

1925. *Sanguinolites albanus* Reed, Rec. Albany Mus., vol. iii, pt. 4, p. 257, pl. ix, figs. 1 and 3 ; pl. x, fig. 4.

Shell elongate-subelliptical with broadly rounded subequal ends, compressed laterally, gaping behind ; inferior margin nearly straight and parallel to hinge-line, with very weak broad median emargination

* Beushausen, Abh. k. preuss. geol. Landesanst., N.F., Heft 17, 1895, p. 211, t. xvii, figs. 1–3.

† *Ibid.*, p. 203, t. xvii, figs. 4–9.

‡ Reed, Geol. Mag., vol. lix, 1922, p. 306, pl. xii, figs. 2, 2*a*, *b*.

§ Prosser and Kindle, Maryland Geol. Surv., 1913, Devonian, p. 271, pl. xxxiii, figs. 11–13.

|| Williams and Breger, *op. cit.*, 1916, p. 223.

¶ Clarke, *op. cit.*, 1899, p. 52, pl. vi, figs. 4–9.

** Clarke, Mem. 9, New York State Mus., pt. 2, 1909, p. 77, pl. xv, figs. 8, 9 (*non* 7, 10, 11).

†† Spriesterbach, Abh. k. preuss. geol. Landesanst., N.F., Heft 80, 1915, p. 68, t. xix, figs. 1–5.

‡‡ *Ibid.*, p. 67, t. xviii, fig. 5.

corresponding to faint lateral depression or flattening of sides ; hinge-line straight with edges slightly exsert, nearly as long as shell. Beaks low, broad, obtuse, situated at about one-third the length of the shell from front end. Surface of valves ornamented with strong broad rounded subequidistant concentric rugae having fine concentric striae between them.

Dimensions (102 Alb. Mus.): Length, 36 mm.; Height, 21 mm.; Thickness, 16 mm.

Remarks.—There is only one example of this species, but it is complete with both valves, and has the shell preserved ; the posterior end is slightly broken, but its outline is easily determined from the concentric rugae. It was labelled "*Palaeoneilo antiqua*, A. G. Bain Collection." With regard to its affinities it is more like the shell figured by Kayser * from the Argentine Devonian as *Leptodomus* sp. than the Brazilian *L. capricornus* Clarke,† for the latter has the shell too elongate, the beaks too forward, and the posterior end more truncate above.

Lept. prunus Clarke,‡ and *Lept. corrugatus* Clarke,§ from the Lower Devonian of North America, may also be compared, and Clarke thinks that the former is closely related to *L. striatulus* (Roemer) ‖ of the Upper Coblenzian, but the latter is quite unlike our shell. The generic name *Leptodomus* has been applied in more than one sense by various writers, and M'Coy's ¶ original application to Carboniferous shells has been lost sight of. Beushausen (*op. cit.*, p. 264) was unable to define clearly the difference between this genus and *Allerisma* (=*Allorisma* Auctt.) King 1849. Wheelton Hind ** points out how M'Coy subsequently changed the scope and definition of *Leptodomus* and thereby caused such confusion that its present retention is of dubious value, and the position and characterisation of the genus is most unsatisfactory. He, therefore, distributes most of M'Coy's species amongst the genera *Protoschizodus*, *Sanguinolites*, and *Allorisma*, and it is probably to the genus *Sanguinolites* that this Bokkeveld specimen should be referred.

In Eastman Zittel's Textbook of Palaeontology, vol. i (1913), p. 439,

* Kayser, Zeitschr. deut. geol. Gesell., vol. xlix, 1897, p. 289, t. x, fig. 6.

† Clarke, "Foss. devon. Parana," 1913, p. 197, pl. xvi, figs. 14–18.

‡ Clarke, Mem. 9, New York State Mus., pt. 2, 1909, p. 76, pl. xvi, fig. 6.

§ *Ibid.*, p. 109, pl. xxviii, fig. 6.

‖ Beushausen, *op. cit.*, p. 265, t. xxiv, figs. 12–14.

¶ M'Coy, Syn. Carb. Foss. Ireland, 1844, p. 67, pl. x, fig. 11.

** Wheelton Hind, "Mon. Carb. Lamellibr.," Palaeont. Soc. 1898 and 1900, pp. 226, 361, 363, 419.

the genus *Leptodomus* is given as only occurring in the Silurian. Williams and Breger * state that *Sanguinolites* gapes behind but not in front, whereas *Leptodomus* gapes at both ends.

Sanguinolites ? sp.

1904. *Sanguinolites* sp. Reed, Ann. S. Afr. Mus., vol. iv, pt. 6, p. 252, pl. xxxi, fig. 4 (98 S.A. Mus.).

The figure of this shell (98 S.A. Mus.) from Ceres which was given by the author in 1904 hardly gives a correct idea of its characters. The shell is made too short and the convexity from the beak to the postero-inferior angle and from the hinge-line to the inferior margin is made insufficient. There seems to have been a weak emargination below the beak on the anterior margin. The impressed line mentioned by me (*op. cit.*) as crossing the shell obliquely seems to be due to an accidental injury. The concentric markings on the shell are made in my figure to look like imbricating lamellae instead of as low rounded rugae. We may also remark that a definite umbonal ridge is wanting, and it should be stated that the straight hinge-line is only about four-fifths the length of the shell.

Williams and Breger think that this Bokkeveld shell resembles their *Modiomorpha* (*Endodesma?*) *Chapmani* † from the Chapman Sandstone of Maine, but it seems to me more like some species of *Sanguinolites* or *Leptodomus*, using the latter name in the same manner as Clarke.

Sphenotus ? cf. *Gorceixi* Clarke.

1904. *Orthonota* aff. *undulata* Reed, Ann. S. Afr. Mus., vol. iv, pt. 6, p. 251, pl. xxxi, fig. 2 (101 S.A. Mus.).

The accuracy of the view which the author expressed in 1904 that this shell was allied to *Orthonota undulata* Conr., was doubted by Clarke,‡ but no further specimens with similar characters have been found in the Bokkeveld Beds, so that the determination of its affinities rests on no new evidence. The specimen is so crushed that its present characters may not be original, but this remark hardly applies to the radial folds. We may, however, add to the original description that there are fine radial striae parallel to the hinge-line along the edges and slopes of the elongated lanceolate ligamental area, and that there is no anterior lunule present. Though there are certain species of

* Williams and Breger, *op. cit.*, 1916, p. 130.

† *Ibid.*, p. 221, pl. xx, figs. 1–7.

‡ Clarke, *op. cit.*, 1913, p. 81.

Orthonota in the Lower Devonian of Germany (such as *O. costata* Kegel, and *O. triplicata* Fuchs), which bear a considerable resemblance to our shell in the possession of radial costae, yet if we bear in mind that our specimen is crushed and distorted we can see a greater resemblance to some examples of *Sphenotus truncatus* Conr. * which has the broad postumbonal slope traversed by a low intermediate ridge, and such is also the case in one small figured specimen of *Sph. Gorceixi* Clarke † from Brazil, with which our shell may probably be compared. Williams and Breger ‡ consider that their *Orthodesma carinifera* sp. nov. from the Chapman Sandstone much resembles the latter Brazilian shell.

Sphenotomorpha Bodenbenderi (Clarke) var. nov. *capensis.*
(Pl. VI, fig. 10.)

Shell transversely elongate, not widening posteriorly, the superior and inferior margins being subparallel ; anterior end sharply rounded ; posterior end broadly rounded, obliquely truncated above, bluntly pointed below ; cardinal margin long, straight, extending three-fourths the length of the shell behind the beaks ; inferior margin nearly straight, very slightly arched, without any insinuation. Beaks low, broad, obtuse, situated near anterior end at about one-sixth the length of the shell, incurved, slightly directed forwards, with indefinite lunule below them. Surface of valves moderately convex, most so at about their middle, with a weak oblique umbonal ridge running back from beak at an angle of 45° to hinge-line but becoming obsolete posteriorly ; surface of valves in front of ridge somewhat flattened and crossed by strong concentric growth ridges and striae of unequal strength ; surface above ridge gently convex or somewhat flattened, with weaker finer concentric markings not angulated on crossing the umbonal ridge.

Dimensions (2019 Kimb. Mus.) :—

Length	. . .	38 mm.
Height	. . .	15 ,,
Thickness	. . .	16 ,,

Remarks.—The specimen from which the above description is

* Hall, Palaeont. New York, vol. v, 1885, pt. 1, p. 394, pl, lxiv, figs. ; Clarke, Mem. 9, New York State Mus., pt. 1, 1908, p. 232, pl. xxii, fig. 11 (*non* figs. 9, 10, 12).

† Clarke, Archiv Mus. Nac. Rio de Janeiro, vol. x, 1899, p. 59. t. v, fig. 14 (*non* 15, 16).

‡ Williams and Breger, *op. cit.*, 1916, p. 126, pl. xix, fig. 2.

drawn up is in the Kimberley Museum (No. 2019), and consists of a complete specimen, both valves being preserved and only the left one slightly crushed and distorted. The locality given is simply "Bokkeveld." Another rather larger specimen in a similar state of preservation was obtained by myself from the roadside cutting north of De Doorns, but it is more crushed, the thickness being exaggerated and the umbonal ridge accentuated by dorso-ventral compression. A third specimen (303 Cape Univ.) from Keurbosch, in the Hex River district, has the beaks crushed in, but the valves are more uniformly convex, and no umbonal ridge seems to be present, and it is more like the typical *Sphenotus Bodenbenderi* Clarke * of the Brazilian Devonian. We may probably refer all of them to the same species, and, apart from the absence of the diagonal furrow which is a noticeable feature in *Sphenotus Bodenbenderi*, there seems to be no difference of specific value. *Orthonota paranensis* Kozl.† from Bolivia may well belong to the same genus, if not species, rather than be allied to *O. undulata* Conr. *Sphenotus elongatus* Spriest.‡ appears to bear much resemblance. Williams and Breger § put *Sph. Bodenbenderi* in their new genus *Sphenotomorpha*.

Toechomya ? rudis (Sharpe).

1856. *Anodontopsis ? rudis* Sharpe, Trans. Geol. Soc., ser. 2, vol. vii, p. 213, pl. xxvii, fig. 10 (11345 Brit. Mus.).

Clarke || established the subgenus *Toechomya* as a subgenus of *Schizodus* Auctt. on the strength of the dentition and internal characters, and chose as the type *T. Rathbuni* sp. nov. from the Devonian of Para. With the external outline and general shape and characters of this species Sharpe's *Anodontopsis ? rudis* appears to correspond most closely and indeed to be almost identical, for the beak should be rather more subcentral and anterior, and the hinge-line longer and straighter behind and rather straighter in front than Sharpe's figure indicates. No other specimen of this peculiar shell has been recognised in any of the collections, and its internal characters are unknown. Williams

* Clarke, Archiv Mus. Nac. Rio de Janeiro, vol. x, 1899, p. 58, t. v, fig. 17; t. viii, figs. 25, 26.

† Kozlowski, Ann. de Paléont., vol. viii, 1913, p. 12, pl. iii, figs. 3, 4.

‡ Spriesterbach, Abh. k. preuss. geol. Landesanst., N.F., Heft 80, 1915, p. 68, t. xix, figs. 1–5.

§ Williams and Breger, *op. cit.*, 1916, pp. 233–236.

|| Clarke, Archiv Mus. Nac. Rio de Janeiro, vol. x, 1899, pp. 54–57, t. viii, figs. 23, 24.

and Breger * regard M'Coy's genus *Anodontopsis* (genotype *A. angustifrons*) as not congeneric with *Cypricardella* Hall (*Microdon* Conrad), of which the genotype comes from the Hamilton Formation of New York. But M'Coy's genus is heteromorphous, and the other species which he placed in it have to be distributed amongst several genera, *A. quadratus* and *A. securiformis* being schizodiform shells. *A. maccoyiana* Will. and Breg.† from the Chapman Sandstone is quite distinct from the Bokkeveld shell.

Buchiola subpalmata, Reed.

1906. *Buchiola subpalmata* Reed, Geol. Mag., Dec. v, vol. iii, p. 302, pl. xvi, figs. 1, 1*a*, 2.

No further examples of this species have come under my observation except one (593) in the Kimberley Museum from Prince Albert, and it is remarkable that the genus has not yet been recorded from the South American Devonian. In North America the genus is well represented in the Upper Devonian (Naples fauna),‡ and its presence in these Bokkeveld Beds suggests that some higher stage than Lower Devonian may occur in the series unless the genus appeared earlier in South Africa than it did in Europe or North America.

The types of *B. subpalmata* were collected on the Zwartberg Pass.

Buchiola sp. ind.

1906. *Buchiola* sp. ind. Reed, Geol. Mag., Dec. v, vol. iii, p. 303.

The characters of this species cannot be satisfactorily defined in the absence of further material.

Cardiola sp. ind.

(Pl. VI, fig. 13.)

A very minute complete internal cast of a lamellibranch about 1·5 mm. long, from Zwartberg Pass, occurs in the collection presented in 1906 to the Sedgwick Museum by the South African Museum. The shell is obliquely suboval, narrowing behind, and is rather strongly biconvex; the umbo is subcentral, being situated in the middle of the hinge-line, but at about one-third the length of the shell, and is rather prominent and swollen, rising well above the short straight

* Williams and Breger, *op. cit.*, 1916, pp. 239–244.

† *Ibid.*, p. 236, pl. xxiv, fig. 14; pl. xxvi, figs. 2, 3, 5–7, 10, 12, 13.

‡ Clarke, Mem. 6, New York State Mus., 1904, pp. 295–303.

hinge-line which is less than half the length of the shell. The anterior cardinal angle is obtuse, the anterior margin being broadly rounded or obliquely subtruncate, and then sweeping round below into the strongly-arched inferior margin which curves round sharply at the narrower posterior angle; the posterior margin is subtruncate and nearly straight, meeting the hinge-line at an angle of about 140°. The anterior part of the valves is rather swollen and inflated, descending somewhat steeply in front; there is no umbonal ridge, and no trace of teeth is visible or of ribs on the surface. We may probably refer this shell to some species of *Cardiola* like *C. concentrica* (von Buch) var. *irregularis* Beush.* or *C.? arciformis* Beush.,† but it is more oblique and narrows more posteriorly than either of them.

Praecardium bokkeveldense, Reed.

1925. *Praecardium bokkeveldense* Reed, Rec. Albany Mus., vol. iii, pt. 4, p. 259, pl. ix, figs. 2, 4, 5.

Shell subtriangular, cardiiform, nearly as high as long, somewhat inflated. Beaks subanterior, pointed, somewhat incurved. Anterior end of shell sharply rounded below, but gently concave in upper half; inferior margin of shell forming a broadly-rounded curve; posterior margin nearly straight, obliquely truncated, meeting the inferior margin at the posterior angle at about 80°. Valves convex, rather swollen on sides, but abruptly truncated behind, the surface above the angular umbonal ridge being flattened and nearly at right angles to the sides, thus forming a large elongated lanceolate posterior area behind the hinge-line. Anterior lunule below beaks shorter and smaller than posterior area, sublanceolate, depressed. Hinge-line short, straight, with one stout triangular peg-like tooth in right valve fitting between two similar teeth in left valve; hinge thickened. Anterior adductor scars small, ill-defined, situated just below lunule close to margin; posterior adductor scars indicated by large curved impressions at end of hinge-line on posterior lanceolate area. Surface of shell ornamented with low, coarse, rounded, closely-placed radial ribs.

Dimensions (91 Alb. Mus.) :—

Height . . .	25 mm.
Length . . .	28 ,,
Thickness . . .	19 ,,

Remarks.—There is only one specimen of this shell, consisting of

* Beushausen, Abh. k. preuss. geol. Landesanst., N.F., Heft 17, 1895, p. 355. t. xxxvii, figs. 18, 19.

† *Ibid.*, p. 357, t. xxxvii, figs. 11, 12.

the complete internal cast of both valves. The external characters, therefore, are rather doubtful, but distinct traces of 3–4 low rounded radial ribs show near the margin in one part, and similar ones probably covered the whole surface.

With regard to the generic position of this shell it is probable that it should be placed in the genus *Praecardium*, or perhaps *Puella*, on account of the presence of teeth, instead of in one of the *Cardiolidae*, which are edentulous.*

The shape of the shell, the high incurved beaks, the anterior lunule, the posterior flattened area, and the radial ribbing would suggest also a comparison with the Devonian species *Opisthocoelus alternans* (Holzapfel) † if the latter were not stated to be edentulous. Clarke ‡ has figured a shell from the New York Oriskany as *Lunulicardium ?* sp., which seems to have much the external shape and ornamentation of our Bokkeveld specimen and to be more like it than *Lunulicardium ? convexum* Clarke,§ from the Gaspé Sandstone, Quebec.

Myalina brevicardinalis sp. nov.

(Pl. VI, fig. 9.)

Shell large, flattened, compressed, obliquely and broadly mytiloid. Beak small, prominent, acute, anterior, terminal; hinge-line short, straight; posterior margin oblique, meeting hinge-line at large obtuse angle (about 130°), nearly straight in upper half, then curving round below to pass into short sharply-arched inferior margin which sweeps up into long, gently-convex anterior margin, becoming concave and curving in below beak. Surface of valves flattened without any umbonal ridge, very gently convex, marked with concentric sub-lamellose growth ridges and striae.

Dimensions (7202 S.A. Mus.):—

Length (oblique) . . .	80 mm.
Length of hinge-line . .	20 ,,
Height (max.) . . .	50 ,,

Remarks.—There is only one right valve (7202 S.A. Mus.) of this

* Douvillé, Bull. Soc. Geol. France, ser. 4, vol. xii, 1912, p. 444; Eastman-Zittel, Textbook of Palaeontology, vol. i, 1913, p. 439.

† Beushausen, Abh. k. preuss. geol. Landesanst., N.F., Heft 17, 1895, p. 340, t. xxxviii, figs. 14–17.

‡ Clarke, Mem. 9, New York State Mus., pt. 2, 1909, p. 141, pl. xxxiii, fig. 23.

§ Clarke, *ibid.*, pt. 1, 1908, p. 234, pl. xxiii, fig. 12.

shell, but it is quite distinct from any other Bokkeveld form, and is somewhat like *Myalina maureriana* Will. and Breg,* or one of its varieties from the Chapman Sandstone of Maine. We may also compare *M. pterinaeoides* Clarke † from the same formation.

Actinopteria Eschwegii, Clarke.

1899. *Actinopteria Eschwegii* Clarke, Archiv Mus. Nac. Rio de Janeiro, vol. x, p. 45, t. v, figs. 1, 2, 4, 5, 6, 8, 9, 10.

? 1899. *Actinopteria Humboldti*, Clarke, *ibid.*, p. 47, t. v, figs. 3, 7, 11, 12.

1904. *Actinopteria* aff. *Boydi* Reed, Ann. S. Afr. Mus., vol. iv, pt. 6, p. 266, pl. xxxii, fig. 9 (81 S.A. Mus.).

? 1904. *Actinopteria* sp., *ibid.*, p. 267.

1905. *Actinopteria Eschwegii* Thomas, Zeitschr. deut. geol. Gesell., Bd. lvii, p. 257, t. viii, fig. 29.

1908. *Actinopteria Eschwegii* Knod, Neues Jahrb. f. Miner., Beil. Bd. xxv, p. 533.

1908. *Actinopteria* aff. *Humboldti*, Reed, Ann. S. Afr. Mus., vol. iv, pt. 8, p. 399, pl. xlviii, fig. 3.

The two Bokkeveld specimens which were respectively considered allied to *A. Boydi* Conr. and *A. Humboldti* Clarke by the present author may both be referred to the species *A. Eschwegii* Clarke, and I have much doubt whether the typical *A. Humboldti* is specifically distinct. Williams and Breger ‡ believe that *A. Boydi* Conr. belongs to the new genus *Actinopterella*,§ but Kegel || puts it in the genus *Leiopteria*, following Spriesterbach's usage.

Pterinopecten ? sp.

1904. *Byssopteria ?* sp. Reed, Ann. S. Afr. Mus., vol. iv, pt. 6, p. 265, pl. xxxii, fig. 8 (82 S.A. Mus.).

The true generic or subgeneric reference of this Pterinea-like shell is doubtful. It may belong to the subgenus *Orbipecten* Frech, or to *Pterinopecten*, and on the whole it seems more likely to belong to the

* Williams and Breger, *op. cit.*, 1916, p. 213, pl. xviii, figs. 1–6, 8, 11 ; pl. xix, figs. 22, 26.

† Clarke, Mem. 9, New York State Mus., pt. 2, 1909, p. 106, pl. xxv, figs. 12–18 ; pl. xxvi, figs. 1–3.

‡ Williams and Breger, *op. cit.*, 1916, p. 184.

§ Williams, Proc. U.S. Nat. Mus., vol. xxxiv, 1908, p. 87.

|| Kegel, Abh. k. preuss. geol. Landesanst., N.F., Heft 76, 1913, p. 58.

latter, for *Pterinopecten proteus* Clarke * of the North American Lower Devonian appears to possess a somewhat similar shape.

Hyolithes subaequalis (Salter).

1856. *Theca subaequalis* Salter, Trans. Geol. Soc., ser. 2, vol. vii, p. 215, woodcuts figs. 3, 4, p. 214 (11351 Brit. Mus.).

1904. *Hyolithes subaequalis* Reed, Ann. S. Afr. Mus., vol. iv, pt. 6, p. 247.

1908. *Hyolithes subaequalis* Reed, *ibid.*, vol. iv, pt. 8, p. 387.

1913. *Hyolithes subaequalis* Clarke, "Foss. devon. Parana," p. 163, pl. viii, figs. 7, 8.

The close resemblance of this species to the Bolivian *H. schencki* Ulrich † has been previously mentioned by me, and it is probable that they are identical. The original specimen (11351 Brit. Mus.) occurs in association with the type of *B. quadrilobatus*. *H. oxys* Clarke,‡ from the Lower Devonian of the Gaspé region, may also be compared.

Hyolithes D'Orbignyi, Kozlowski, var. nov. *capensis*.

(Pl. VII, figs. 2, 2*a–c*.)

Cf. 1923. *Hyolithes d'Orbignyi* Kozlowski, "Faune Devon. Bolivie," Ann. Paléont., vol. xii, p. 71, pl. x, figs. 8–11.

There is one good example of a *Hyolithes* from the Zwartberg Pass which can scarcely be distinguished from the Bolivian *H. D'Orbignyi*. It is in the Kimberley Museum (2018 Kimb. Mus.), and there is also the impression of the exterior of the same individual showing the ventral (convex) face on which the longitudinal as well as the transverse striae are visible. The internal cast of which the tip is broken shows the impressed line at the lateral angles, which Kozlowski mentions. The specimen now measures 32 mm. in length, 14 mm. in diameter at its upper end, and 9 mm. in thickness, but when perfect it must have had a length of about 42 mm. Our shell differs from the South American species in the longitudinal striae being very delicate and much finer than the transverse growth-striae instead of being equal to them in size.

* Clarke, Mem. 3, New York State Mus., 1900, p. 32, pl. iv, figs. 4–8; *ibid.*, Mem. 9, pt. 2, 1909, p. 156, pl. xix, figs. 2, 3.

† Ulrich, Neues Jahrb. f. Miner., Beil. Bd. viii, 1893, p. 37, t. iii, figs. 9*a–d*; Knod, *ibid.*, Beil. Bd. xxv, 1908, p. 517, t. xxiii, fig. 7.

‡ Clarke, Mem. 9, New York State Mus., pt. 1, 1908, p. 143, pl. xii, figs. 10–13.

Conularia africana, Sharpe.

1856. *Conularia africana* Sharpe, Trans. Geol. Soc., ser. 2, vol. vii, p. 214, pl. xxvii, figs. 13*a*, 13*b* (11348 Brit. Mus.) [*non* fig. 13*c* (11349 Brit. Mus.)].

1904. *Conularia africana* Reed, Ann. S. Afr. Mus., vol. iv, pt. 6, p. 247 (for earlier references).

1906. *Conularia africana* Schwarz (pars), Rec. Albany Mus., vol. i, pt. 6, p. 362 (*non* pl. vii, figs. 13, 14, 15).

? 1908. *Conularia africana* Knod, Neues Jahrb. f. Miner., Beil. Bd. xxv, p. 516, t. xxiii, figs. 8, 9.

1913. *Conularia africana*, Clarke, "Foss. devon. Parana," p. 160, pl. viii, figs. 12–15.

1920. *Conularia africana* Douglas, Quart. Journ. Geol. Soc., vol. lxxvi, p. 37, pl. i, fig. 1.

? 1923. *Conularia africana* Kozlowski, Ann. Paléont., vol. xii, p. 67, pl. vii, figs. 1–3.

The best collection of examples of this genus from the Bokkeveld Beds is in the Albany Museum, but not all the specimens which Schwarz recorded under the name *africana* can be left in it. The state of preservation and the fragmentary condition of many of the specimens makes the specific determination a frequent matter of difficulty. The type specimen (Sharpe, pl. xxvii, figs. 13*a*, 13*b*) (11348 Brit. Mus.) is in the British Museum and was obtained from the Cedarberg. Kozlowski (*op. cit.*) separates the Bolivian representatives of this species described by Ulrich, Knod, and himself as a distinct variety which he terms *striatula* owing to the presence of longitudinal striations; but whether their absence is due to the state of preservation or not is uncertain, for some of the Bokkeveld specimens seem to possess them on parts of the surface, though elsewhere indistinguishable.

In the type specimen of *C. africana* Sharpe (*op. cit.*, figs. 13*a*, 13*b*) (11348 Brit. Mus.) the transverse ribs on the faces of the shell are interrupted by a median longitudinal more or less impressed line, and the two halves of the ribs slightly overlap or alternate, but towards the mouth they are continuous, the median line disappearing, and they undulate in a gentle upward curve or run nearly straight across. The peculiar appearance of double lines with a fine groove between them together forming the transverse ribs which Sharpe represents in his figure and describes as "two sharp ridges enclosing a rounded furrow," are due to the fact that the transverse ribs are hollow and have had their crests abraded. They show no trace of tubercles.

Conularia africana Sharpe var. nov. *albertensis.*

(Pl. VII, figs. 3, 3*a*, *b*.)

? 1893. *Conularia undulata* Ulrich (*non* Conrad), Neues Jahrb. f. Miner. Geol., Beil. Bd. viii, p. 31, t. iii, figs. 6*a*, 6*b*.

Shell elongated pyramidal, quadrangular in cross section, rectangular, tapering to apex at about 1 in 3, and slightly curved to one side. Sides flat, of unequal width, the anterior and posterior faces being wider than the lateral ones; each face marked with strong impressed median longitudinal line and each angle infolded and grooved for its whole length; faces crossed by regular equal equidistant thick transverse thread-like lines (ribs), very minutely granulated along sharp crest, gently arched upwards, but not angulated on crossing median longitudinal line nor alternating on opposite sides of it; 8–9 transverse lines in a space of 5 mm., separated by concave rounded smooth grooves fully twice the width.

Dimensions (2017 Kimb. Mus.):—

Length of specimen (apex missing)	.	80 mm.
Estimated length of perfect specimen	.	110 ,,
Width of anterior face at upper end	.	36 ,,
,, lateral ,, ,, ,,	.	32 ,,

Remarks.—There is one good specimen from Prince Albert in the Kimberley Museum (2017 Kimb. Mus.). It differs from *C. africana* in having the strong median impressed line for the whole of each face, and the minutely-granulated finer transverse lines, though the rate of tapering and gently arching of the transverse lines agree.

The *C. undulata* Conr. described by Ulrich * from Bolivia agrees in shape, rate of tapering, transverse section, and longitudinal lines on each face, but has more numerous transverse lines which also are angulated in the middle. The specimen from Koudeveld Berg (80 S.A. Mus.) which the author † compared with *C. undulata* in 1904 has more numerous transverse lines than *C. albertensis*, and does not seem identical with the Bolivian form, as Kozlowski ‡ remarks.

* Ulrich, Neues Jahrb. f. Miner. Geol., Beil. Bd. viii, 1893, p. 31, t. iii, figs. 6, 6*a*; Knod, *ibid.*, Beil. Bd. xxv, 1908, p. 513, t. xxiv, figs. 1, 2; t. xxxi, fig. 3.

† Reed, Ann. S. Afr. Mus., vol. iv, pt. 6, p. 248, pl. xxxi, figs. 1, 1*a*.

‡ Kozlowski, *op. cit.*, 1923, p. 70, pl. vii, fig. 7.

Conularia Baini, Ulrich.

1893. *Conularia Baini* Ulrich, Neues Jahrb. f. Miner., Beil. Bd. viii, p. 36, t. iii, fig. 8.
1906. *Conularia africana* Schwarz (pars), Rec. Albany Mus., vol. i, pt. 6, p. 362, pl. vii, fig. 14 (*non* 13, 15).
1920. *Conularia Baini* Douglas, Quart. Journ. Geol. Soc., vol. lxxvi, p. 37, pl. i, fig. 2.
1923. *Conularia Baini*, Kozlowski, Ann. Paléont., vol. xii, p. 68, pl. vii, fig. 4.

The short, broadly-pyramidal form, tapering at about 1 in 2–2½, which Ulrich separated off as *Con. Baini*, though it is usually included in *C. africana*, is represented in the Albany Museum by one of the specimens figured by Schwarz (116 Alb. Mus.) as *C. africana*. Kozlowski says that one of the distinguishing characters are the longitudinal lines, and Ulrich says that the transverse ribs are set with tubercles, though these have usually been rubbed off. Such is the case in one of the specimens (116 Alb. Mus.) in the Albany Museum, though it fails to show the longitudinal lines. The latter, however, show in places in a specimen (793 S.A. Mus.) from an unknown locality, and in a fragment (1478 Alb. Mus.) where not only these short transverse lines across the interspaces but also the small low tubercles or granules on the ribs are seen, particularly in the impress (117 Alb. Mus.) of the surface of the same specimen.

Dimensions (793 S.A. Mus.) :—

Length of fragment . . .	37 mm.
Diameter at mouth . . .	31 ,,
,, at end of fragment . .	12 ,,
Rate of tapering	1 in 2.

C. lata Hall *mut.*,* as described and figured by Clarke from the Grande Grève Limestone of Gaspé, has a similar shape and identical ornamentation, and perhaps Kozlowski's *Conularia* sp.† from Parana is identical with our Bokkeveld form. We may suspect that the imperfectly preserved form (88 Alb. Mus.), to which was attached ‡ the MS. name *C. pinchiniana* Salt., belongs to this species, but the ribs are coarser and more widely separated.

* Clarke, Mem. 9, New York State Mus., pt. 1, 1908, p. 144, pl. xi, figs. 6–9.

† Kozlowski, Ann. Paléont., vol. viii, 1913, p. 11, pl. xii, figs. 13, 14.

‡ Schwarz, *op. cit.*, p. 363, pl. vii, fig. 15.

Conularia gamkaensis sp. nov.

1904. *Conularia* cf. *acuta* Roemer, Reed, Ann. S. Afr. Mus., vol. iv, pt. 6, p. 249, pl. xxx, fig. 11 (75 S.A. Mus.).

This form is not identical with *C. ulrichana* Clarke, differing by the transverse position and laterally compressed oval shape of the tubercles which are set across the concentric ribs. The characters were described by me in 1904, and the shell seems to deserve a new specific name. As Kozlowski * pointed out, it does not agree with *C. acuta* Roemer nor with *C. ulrichana,* for the ornamentation and number of the ribs in the same space are different. A fine specimen in four pieces (2607 Alb. Mus.) from the same locality, Gamka Poort, mentioned by Schwarz (*op. cit.*, 1906, p. 363) as *C.* cf. *acuta,* occurs in the Albany Museum. In it the face preserved is gently concave ; the concentric ribs are thick, continuous across the face, regularly and gently curved upwards, equidistant, not interrupted in the middle of the face, and they number 16–18 in 5 mm., but distally seem wider apart, as in the Cape Town specimen (75 S.A. Mus.). The tubercles which cross the ribs are of the nature of transverse rings which are close and equidistant and form scarcely-interrupted longitudinal series, for, as mentioned in the case of the Cape Town example, the grooves are crossed by their continuation from rib to rib.

Conularia ulrichana, Clarke.

? 1856. *Conularia africana* Sharpe (pars), Trans. Geol. Soc., ser. 2, vol. vii, p. 214, pl. xxvii, fig. 13*c* (1349 Brit. Mus.), *non cet.*

1906. *Conularia africana* Schwarz (pars), Rec. Albany Mus., vol. i, pt. 6, p. 362, pl. vii, fig. 13 (1483, 15, 1479 Alb. Mus.).

1913. *Conularia ulrichana* Clarke, "Foss. devon. Parana," p. 161, pl. viii, figs. 16–21.

1923. *Conularia ulrichana* Kozlowski, "Foss. Dev. Bolivie," Ann. Paléont., vol. xii, p. 69.

There is a fine group of four or five examples of a species of *Conularia* on a slab (36 S.A. Mus.) in the South African Museum from an unknown locality, which show the characters of *C. ulrichana* Clarke rather than of *C. africana,* for the fine transverse narrow ribs, though having the same curvature and behaviour as the last-mentioned

* Kozlowski, *op. cit.*, 1923, p. 69.

species, possess a row of minute equidistant granules along their crest of equal size. It is also noticeable that towards the apex the transverse ribs, instead of being continuous across the median longitudinal line on each face, tend to be interrupted and to alternate, while the halves thus formed are straighter and meet at an obtuse angle instead of forming a continuous gentle curve. The specimen (11349 Brit. Mus.) which Sharpe figured as *C. africana*, but only in transverse section, shows similar minute tubercles on the transverse ribs, and there is a specimen from Ezelfontein with similar characters (E. 455) in the Stellenbosch Museum. Some of Schwarz's specimens which he referred to *C. africana* in the Albany Museum (1483 Alb. Mus.) may also be relegated to *C. ulrichana*, in which Kozlowski (*op. cit.*) includes Ulrich's *C.* cf. *acuta* Roemer, from Bolivia, but not the author's Bokkeveld shell, which was compared with it, but now has been recognised as distinct under the name *gamkaensis*.

Conularia Quichua, Steinmann and Döderlein.

1893. *Conularia Quichua* Ulrich, Neues Jahrb. f. Miner., Beil. Bd. viii, p. 34, t. iii, figs. 7*a*, *b*.
1897. *Conularia Quichua* Kayser, Zeitschr. deut. geol. Gesell., vol. xlix, p. 288, t. xi, figs. 1, 2.
1904. *Conularia Quichua* Reed, Ann. S. Afr. Mus., vol. iv, pt. 6, p. 248, pl. xxx, figs. 10, 10*a* (72 S.A. Mus.).
1905. *Conularia Quichua* Thomas, Zeitschr. deut. geol. Gesell., vol. lvii, p. 254, t. xii, figs. 19, 19*a*.
1908. *Conularia Quichua* Knod, Neues Jahrb. f. Miner., Beil. Bd. xxv, p. 515.
1913. *Conularia Quichua*, Clarke, "Foss. devon. Parana," p. 163.
1920. *Conularia Quichua*, Douglas, Quart. Journ. Geol. Soc., vol. lxxvi, p. 37, pl. i, fig. 3.
1923. *Conularia Quichua*, Kozlowski, Ann. Paléont., vol. xii, p. 69, pl. vii, fig. 5.

Kozlowski does not think that the Bokkeveld shell which I attributed to *C. Quichua* is identical with the South American form on which the species was founded, but I see no adequate reason for separating them. Another specimen (15 Brit. Mus.), from the Cedarberg, has been recognised in the British Museum. Douglas (*op. cit.*) is of opinion that the Taya Taya beds of Peru, in which *C. Quichua* occurs, may be correlated with the lower part of the Middle Devonian (Hamilton Group) of North America.

Diaphorostoma Baini (Sharpe).

1856 *Littorina? Baini* Sharpe, Trans. Geol. Soc., ser. 2, vol. vii, p. 213, pl. xxvii, figs. 11, 12 (11346, 11347 Brit. Mus.).

? 1875. *Holopea furmanianum* Hartt and Rathbun, Ann. New York Lyceum Nat. Hist., vol. xi, p. 115.

? 1899. *Diaphorostoma furmanianum*, Clarke, "Devon. Mollusca of Para," Archiv Mus. Nac. Rio de Janeiro, vol. x, p. 32, pl. iv, figs. 10–13.

1904. *Holopea Baini* Reed, Ann. S. Afr. Mus., vol. iv, pt. 6, p. 245.

? 1908. *Diaphorostoma furmanianum* Knod, Neues Jahrb. f. Miner. Geol., Beil. Bd. xxv, p. 510.

? 1913. *Diaphorostoma allardycei* Clarke, "Foss. devon. Parana," Mon. Serv. Geol. Miner. Brasil, vol. i, p. 175, pl. ix, figs. 8–10.

? 1923. *Diaphorostoma* cf. *furmanianum* Kozlowski, Ann. de Paléont., vol. xii, p. 76, pl. viii, figs. 21, 21*a*.

There does not seem to be any sufficient reason for separating the three species, *D. Baini*, *D. allardycei*, and *D. furmanianum* from South Africa, the Falkland Isles, and South America. Specimens (14444 Brit. Mus.) from the Gydo Pass show transitional shapes with variation in the apical angle, and I have compared specimens in the Albany Museum from the Falkland Islands with them.

Diaphorostoma? sp.

1904. *Diaphorostoma?* sp. Reed, Ann. S. Afr. Mus., vol. iv, pt. 6, p. 245 (161, 162, 163 S.A. Mus.).

The original specimens from Gamka Poort are very crushed and imperfect, and their true affinities and even generic position are uncertain, but it seems much like *Pleurotomaria* sp. β * which Thomas describes from Argentina.

Platyceras bokkeveldense sp. nov.

(Pl. VII, fig. 1.)

Shell globose, obliquely ovoid, subheliciform, low, composed of 3–4 subcircular whorls loosely coiled, but in contact the upper 2–3 whorls very small and forming low apex, the body whorl large, forming greater part of shell, rapidly expanding to large subcircular campanulate mouth. Surface with faint traces of concentric encircling lines.

* Thomas, Zeitschr. deut. geol. Gesell., vol. lvii, 1905, p. 254, t. xii, figs. 18, 15*a*.

Dimensions (2442 S.A. Mus.) :—

Length	30 mm.
Height	*c.* 16 ,,
Width of mouth (max.) . .	20 ,,

Remarks.—There is only one specimen (2442 S.A. Mus.) of this species, and it consists of an internal cast from Koudeveld Berg in the South African Museum. We may compare it with *Platyceras Gebhardi* Conrad * of the Oriskany Sandstone rather than with any species of *Platyceras* from Bolivia such as Knod † and Kozlowski ‡ have described.

Loxonema capense, Reed.

1904. *Loxonema* sp. Reed, Ann. S. Afr. Mus., vol. iv, pt. 6, p. 244, pl. xxx, fig. 8 (164, 163 S.A. Mus.).

1908. *Loxonema capense*, Reed, *ibid.*, vol. iv, pt. 8, p. 405.

This species, which was described but not named in 1904, had the name *capense* subsequently (1908) suggested for it. Much better specimens have now come under my notice (7173 S.A. Mus.), and the very slightly inflated whorls and scarcely sunken sutures distinguish it from the other Bokkeveld species. It is allied to *L. glabrum* Kozl.§ of the Bolivian Devonian, as Kozlowski remarks, but its rate of tapering is slower. In the Kimberley Museum internal casts from Paarde Bont, Oudtshoorn district (3287 Kimb. Mus.), exhibit the typical characters.

Loxonema zwartbergense sp. nov.

(Pl. VII, figs. 4, 4*a*.)

Shell turreted, slender, slowly tapering, composed of many (? 8–10) whorls ; apical angle 20°–25° ; whorls gently convex, about $1\frac{1}{2}$ times as wide as high ; suture line rather deep, inclined at about 75° to axis ; subsutural band very narrow. Surface of whorls crossed by fine granulated lines (?) meeting the sutures nearly at right angles.

* Hall, Palaeont. New York, vol. iii, 1859, p. 312, pl. lvi, figs. 5, 6, 7, 9 ; p. 474, pl. cxvii, figs. 1–10. Ohern and Maynard, Maryland Geol. Surv., Lower Devonian, 1913, p. 470, pl. lxxx, figs. 2–9.

† Knod, Neues Jahrb. f. Miner., Beil. Bd. xxv, 1908, p. 511, t. xxiii, figs. 8, 8*a*, *b*.

‡ Kozlowski, *op. cit.*, 1923, p. 75, t. viii, figs. 19, 19*a*.

§ *Ibid.*, p. 74, t. x, fig. 13.

Remarks.—This shell (624 S.A. Mus.) from the Zwartberg Pass, is undoubtedly distinct from *L. capense*, the whorls being more swollen and the suture lines more sunken, so that it seems to deserve a distinctive name. It is rather a common form and seems much like the shell occurring in the Bolivian Devonian which Knod * considers allied to *L. attenuatum* Hall, but it is less elongated and the suture line makes a larger angle with the axis. Our specimen (624) consists of an external impression and internal cast of the 5 basal whorls, measuring about 23 mm. in length. The diameter of the basal whorl is about 8 mm., and its height nearly 6 mm. In the British Museum (G. 1711) there are examples from Keurbooms River.

We may compare it with the American species *L. welleriana* Will. and Breg.† from the Chapman Sandstone.

Loxonema cf. *gregarium*, Knod.

There is one imperfect specimen (5421 S.A. Mus.) of a turriculate gastropod showing the 4 lower whorls of the shell, including the basal one on which the ornamentation is preserved on part of the surface. The apical angle, sutural angle, subsutural band, and proportions of the whorls are indistinguishable from *L. capense*, so far as the state of preservation of the specimen allows us to determine the characters, but the ornamentation consists of transverse, very slightly arched, raised, equidistant, thread-like lines, much as in *Loxonema funatum* Roemer, with which a form ‡ from the Chapman Sandstone of Maine has been compared. But *L. gregaria* § Knod, from the Icla Shales of Bolivia, is more closely allied, and our Bokkeveld specimen may be at any rate compared with it, though it is too poor for a precise description. Knod considers that his species resembles *L. delphicola* Hall, of the Hamilton Group, and we may also mention *L. hamiltoniae* Hall,‖ of the same formation.

Our specimen was collected at Roode Hoogbe Kloof, between Montagu and Triangle.

* Knod, *op. cit.*, 1908, p. 509, t. xxiii, fig. 4.

† Williams and Breger, Prof. Paper 89, U.S. Geol. Surv., 1916, p. 279, pl. xiii, figs. 2, 3, 5.

‡ Clarke, Mem. 9, New York State Mus., pt. 2, 1909, p. 102, pl. xxiii, figs. 25 and 26.

§ Knod, Neues Jahrb. f. Miner. Geol., Beil. Bd. xxv, 1908, p. 508, t. xxiii, figs. 3, 3*a*.

‖ Prosser and Kindle, Maryland Geol. Surv., 1913, Devonian, p. 294, pl. xxxvi, figs. 16–19.

Palaeoscurria Sharpei sp. nov.

(Pl. VII, figs. 5, 5*a*, *b*.)

1856. *Orbicula Baini*, Sharpe (pars), Trans. Geol. Soc., ser. 2, vol. vii, p. 210, pl. xxvi, fig. 20 (11332 Brit. Mus.) *non* figs. 21–23.

? 1893. *Discina Baini*, von Ammon, Zeitschr. Gesell. Erdkunde, vol. xxviii, p. 359, fig. 4.

Shell subcircular to subovate, capuliform; apex eccentric, directed backwards, situated at one-sixth (or less) the diameter from posterior edge, with steep or nearly vertical slightly-concave slope below it; anterior slope convex, rounded; maximum height of shell in front of apex. Surface marked with strong concentric unequal growth-striae, crowded together on posterior slope and more widely spaced anteriorly, all crossed by very delicate close radial lines.

Dimensions (B. 45501 Brit. Mus.):—

Length . . .	20·0 mm.
Diameter . . .	21·0 ,,
Height (max.) . .	9·0 ,,

Remarks.—The first specimen (11332 Brit. Mus.) from the Bokkeveld Beds of Gydo Pass which Sharpe figured as *Orbicula Baini* is quite distinct from all the others and from the generally-accepted type of this species. But his definition agrees better with it than with them, for he describes it as "testâ ovato-circulari, depresso-conicâ, apice excentricâ, concentrica subrugatâ, radiatim subtilissimè striatâ." He does not, however, show the radial striae in his figure, though they show in the specimen, and the shell should be described as capuliform rather than conical, the arched back and slightly depressed backwardly directed apex with steep posterior slope below it being marked features.

Von Ammon (*op. cit.*) has apparently found the same kind of shell in Brazil. In the true *O. Baini* the concentric lines are sharp, equal, equidistant, and not crowded together posteriorly, the apex is sharper and more central, the whole shell is conical, and there are no external radial striae, the only radial lines present belonging to an inner layer of the shell, and only becoming visible in those places where the outermost concentrically ridged layer has been removed or broken.

In my previous description of the Bokkeveld fossils in 1903 (Ann. S. Afr. Mus., vol. iv, pt. 4, p. 168), the distinction between these two types of shells was overlooked. But we must certainly remove the above-described species from *O. Baini*, and, moreover, not only put

it in another species and genus, but regard it as a gastropod allied to *Palaeoscurria gibbosa* (Barr) as described by Perner * from Stage F. f. 2 in Bohemia. The apex in both the specimens in the British Museum is broken. The shell figured here is from the Gydo Pass, as is also Sharpe's example.

Metoptoma capense, Reed.

1908. *Metoptoma capense* Reed, Ann. S. Afr. Mus., vol. iv, pt. 8, p. 385, pl. xlvii, figs. 1, 2 (1178 S.A. Mus.).

No further examples of this shell have been observed in any of the collections. The poorly preserved specimens bearing this name in the Albany Museum seem to have been erroneously identified.

Pleurotomaria aff. *Kayseri*, Ulrich.

1904. *Pleurotomaria* aff. *Kayseri* Reed, Ann. S. Afr. Mus., vol. iv, pt. 6, p. 241, pl. xxx, fig. 3 (70*f* S.A. Mus.).

1913. *Pleurotomaria Kayseri* Clarke, "Foss. devon. Parana," p. 164, pl. ix, fig. 12.

There is no further example of this shell from the Bokkeveld Beds, but Knod † again records the species from Bolivia, and Clarke from Brazil. Probably it belongs to the subgenus *Eotomaria*, and is allied to *E. delia* (Billings).‡

Bellerophon (*Plectonotus*) *fraternus*, Reed.

? 1906. *Bellerophon Reissi* Schwarz, Rec. Albany Mus., vol. i, pt. 6, pl. viii, figs. 1, 1*a* (128 Alb. Mus.).

1908. *Bellerophon* (*Plectonotus*) *fraternus* Reed, Ann. S. Afr. Mus., vol. iv, pt. 8, p. 386, pl. xlvii, figs. 3, 3*a*, 4 (25 (1180) S.A. Mus.).

As previously remarked, the resemblance of this species to *B.* (*Pl.*) *Salteri* Clarke, of the Brazilian Devonian is close. *B.* ("*Bucaniella*") *Dereimsi* Knod is less closely allied. The shell which Schwarz identified with *B. Reissi* Clarke § is more probably referable to our *B. fraternus*. Kegel || has described and figured a European species from the Lower Devonian of Germany under the

* Perner, Syst. Silur. Boheme, Gastropoda, vol. iv, t. i, 1903, p. 50; t. ii, 1907, pl. civ, figs. 18–20.

† Knod, *op. cit.*, 1908, p. 508.

‡ Clarke, Mem. 9, New York State Mus., pt. 1, 1908, p. 151, pl. xvi, figs. 6–8, 17.

§ Clarke, Archiv Mus. Nac. Rio de Janeiro, vol. x, 1899, p. 37, pl. iii, figs. 7–9.

|| Kegel, Abh. k. preuss. geol. Landesanst., N.F., Heft 76, 1913, p. 45, t. iii, fig. 1.

name *B.* (*Bucaniella*) *regius* which much resembles our Bokkeveld shell. Williams and Breger * refer the closely-similar trilobed American shells from the Chapman Sandstone of Maine to Sowerby's Silurian species *B. trilobatus*, but this name requires a more restricted application.

Bellerophon (*Plectonotus*) cf. *Dereimsi* (Knod).

1904. *Bellerophon* (*Bucaniella*) aff. *trilobatus*, Reed, Ann. S. Afr. Mus., vol. iv, pt. 6, p. 242, pl. xxx, fig. 5 (213 S.A. Mus.).
1908. *Bucaniella Dereimsi*, Knod, Neues Jahrb. f. Miner. Geol., Beil. Bd. xxv, p. 506, t. xxii, figs. 4, 5.
1913. *Plectonotus* (*Bucaniella*) *Dereimsi*, Clarke, "Foss. devon. Parana," p. 165, pl. ix, figs. 13–17.

This species, which was founded by Knod on internal casts from Bolivia, but has been subsequently described from Brazil by Clarke, is closely allied to *B. fraternus*, but has deeper revolving furrows and a relatively wider and more rapidly expanding median lobe on the back. The revolving lines which ornament the exterior, as Clarke shows in his figures of specimens from Ponta Grossa, are preserved in some of the examples from the Bokkeveld Beds of Gydo Pass (213) in the South African Museum, but usually we have only internal casts with which to deal. *Pl. Derbyi* Clarke,† from Brazil and Maine,‡ seems to be an allied species, but has a much less expanded mouth, and therein resembles *B.* (*Pl.* ?) *gaspensis* Clarke § from the Grande Grève Limestone of Gaspé. It should be mentioned that Clarke's Brazilian examples of *B. Dereimsi* seem to differ from Knod's type from Bolivia, and Clarke himself notices several points of difference, and we may doubt if they really belong to the same species.

Bellerophon (*Plectonotus*) cf. *laticarinatus* (Knod).

? 1904. *Bellerophon* (*Plectonotus*) cf. *Reissi* Reed, Ann. S. Afr. Mus., vol. iv, pt. 6, p. 243, pl. xxx, figs. 6, 6*a* (107 S.A. Mus.).
1905. *Tropidocyclus* cf. *Gilletianus*, Thomas, Zeitschr. deut. geol. Gesell., vol. lvii, p. 253, t. xii, figs. 13*a*, *b*.
1906. *Bellerophon trilobatus* Schwarz, Rec. Alb. Mus., vol. i, pt. 6, pl. viii, fig. 2 (139 Alb. Mus.).

* Williams and Breger, *op. cit.*,1916, p. 206, pl. xiv, figs. 1, 1*a*, *b*, 12, 13, 17–19, 28.

† Clarke, Archiv Mus. Nac. Rio de Janeiro, vol. x, 1899, p. 38, t. iii, figs. 14–18.

‡ Clarke, Mem. 9, New York State Mus., pt. 2, 1909, p. 98, pl. xii, figs. 17–19; pl. xxiv, figs. 1–11.

§ *Ibid.*, pt. 1, 1908, p. 154, pl. xvii, figs. 17, 18.

? 1908. *Bellerophon* (*Tropidocyclus*) cf. *gilletianus*, Reed, Ann. S. Afr. Mus., vol. iv, pt. 8, p. 385.

1908. *Bucaniella laticarinata* Knod, Neues Jahrb. f. Miner. Geol., Beil. Bd. xxv, p. 505, t. xxii, figs. 6, 6*a*.

1913. *Bucaniella laticarinata*, Kozlowski, Ann. Paléont., vol. viii, p. 10, pl. xii, figs. 12, 12*a*.

Knod's species was founded on internal casts, but it is probable that the Brazilian *B. hapsideus* Clarke * is closely allied. A number of small specimens of this type occur in the Albany Museum (Nos. 124, 129, 126, 140, 141, 139) from the Warm Bokkeveld, and others in the South African Museum (3794 S.A. Mus.) from Laken Vlei, Ceres, show traces of ornamentation like *B. hapsideus*. Williams and Breger † refer the true *B. gilletianus* and its allies to *Tropidodiscus*.

Bellerophon (*Plectonotus*) *quadrilobatus*, Salter.

1856. *Bellerophon quadrilobatus* Salter, Trans. Geol. Soc., ser. 2, vol. vii, p. 214, text-figs. 1, 2 (11351 Brit. Mus.).

1904. *Bellerophon quadrilobatus* Reed, Ann. S. Afr. Mus., vol. iv, pt. 6, p. 242.

? 1913. *Bellerophon quadrilobatus* Salter ? Clarke, "Foss. devon. Parana," pl. ix, fig. 11.

Clarke (*op. cit.*) has figured a specimen from West Falkland which he doubtfully identifies with Salter's South African species. It is clear that this species belongs to the same group as *B. fraternus*, *B. Dereimsi*, *B. laticarinatus*, etc., which are characteristic of the Lower Devonian in the southern hemisphere.

The type specimen (11351) in the British Museum is from the Warm Bokkeveld, and shows the quadrilobation of the dorsum more distinctly than represented in Salter's text-figures (*op. cit.* p. 214, figs. 1, 2). There is a specimen (27 S.A. Mus.) from Gamka Poort in the South African Museum which also shows the typical characters, but this species does not seem common.

Bellerophon (*Plectonotus ?*) aff. *Reissi*, Clarke.

1904. *Bellerophon* aff. *Salteri* Clarke, Reed, Ann. S. Afr. Mus., vol. iv, pt. 6, p. 243, pl. xxx, figs. 7, 7*a* (108 S.A. Mus.).

The true reference of this shell is uncertain. The presence of a

* Clarke, *op. cit.*, 1913, p. 166, pl. ix, figs. 1–5.

† Williams and Breger, *op. cit.*, p. 272.

broad revolving peripheral band, such as Knod (*op. cit.*) shows in his *Bucaniella Dereimsi* and Clarke in his *Plectonotus Derbyi*,* seems sufficient to mark it off from the true *B. Salteri*. As Clarke states, "differing conditions of preservation have produced differing opinions as to the presence of a slit band," and Meek, Koken, Knod, and Clarke do not agree about its presence in many of these apparently allied species. In shape and weak trilobation our shell seems more like *B. Reissi* Clarke † than *B. Salteri*, but I am doubtful about its relationships.

Bellerophon (*Patellostium*) *africanoides* sp. nov.

(Pl. VII, figs. 6, 6*a*, *b*.)

Shell of few whorls ($2\frac{1}{2}$), high, broad, strongly convex, rapidly expanding in width but more slowly in height; spire small; whorls not closely enrolled, but in contact; umbilicus deep, open, with sharply-rounded edges. Outer whorl with broad rounded dorsum, wide transversely expanded subelliptical mouth having a broad shallow open median emargination forming a very weak sinus in the dorsal lip (which is not reflexed); lateral lips much expanded, simple and not reflexed; lower lip reflexed. Submarginal internal thickening on dorsal lip (forming a concentric groove with a median sinus on internal cast). No trace of slit-band.

Dimensions (14 Cape Univ.) :—

Height of shell . .	32 mm.
Width of mouth . .	38 mm.
Height of mouth . .	*c.* 24 mm.

Remarks.—We have only one internal cast of this species and it is from an unknown locality, but it is in good preservation. It is preserved in the collection of the University of Cape Town (14), and is undoubtedly distinct from any previously described from the Bokkeveld Beds. We may especially compare it with *B.* (*Patellostium*) *revolvens* Will. and Breg.,‡ of the Moose River Sandstone, Maine, which they consider to be similar to *B. Freitasi* Clarke,§ from Brazil. *B.* (*Ptomatis*) *Moreirai* Clarke,‖ from Ponta Grossa, seems also closely allied to our species.

* Clarke, Archiv Mus. Nac. Rio de Janeiro, vol. x, 1890, p. 38, pl. iii, figs. 14–18.

† *Ibid.*, p. 37, t. iii, figs. 7–9.

‡ Williams and Breger, *op. cit.*, 1916, p. 265, pl. xiv, figs. 14, 15, 20, 27.

§ Clarke, *op. cit.*, 1899, p. 35, pl. iii, fig. 22.

‖ Clarke, *op. cit.*, 1913, p. 173, pl. ix, figs. 18–20.

Bellerophon (*Tropidodiscus*) cf. *globosus*, Knod.

There is a small *Bellerophon* in the Bain Collection in the Albany Museum from the Warm Bokkeveld, which has a high rounded parabolic or subangular dorsum ; the outer whorl slowly expands in width but more rapidly in height, and completely envelops the inner whorls ; the umbilicus is small, is situated at about one-third the height, and has a rectangular edge and steep descent. There is no sign of trilobation, and it seems that the shell much resembles the Argentine one which Kayser * thought allied to *B. Murchisoni* D'Orb., but to which Knod † gave the new specific name *globosus*, which is an unfortunate choice as the shell is the reverse of globose.

Dimensions :—

Height of shell . . .	18·0 mm.
Antero-posterior diameter . .	*c.* 12·0 mm.
Transverse diameter near mouth	*c.* 11·0 mm.
Height of umbilicus from base .	6·5 mm.

Remarks.—The species from the Chapman Sandstone described as *Tropidodiscus obex* Clarke ‡ is probably allied, and *Tropidocyclus antarcticus* Clarke § from the Falkland Isles may also be compared.

Bellerophon cf. *morganianus*, Hartt and Rathbun.

1904. *Bellerophon* cf. *morganianus* Reed, Ann. S. Afr. Mus., vol. iv, pt. 6, p. 241, pl. xxx, figs. 4, 4*a* (110 S.A. Mus.).

No further example of this type of *Bellerophon* has been found. Its large expanded mouth and fine dorsal band suggest that it is rather more allied to *Bellerophon plenus* Billings, as figured by Clarke ‖ from the Grande Grève Limestone of Gaspé, than to *B. morganianus* Hartt and Rathbun, which is characterised by the flattening of the inner portion of the body whorl.¶ The Argentine shell which Thomas ** figured as *Ptomatis* sp. appears to be much like our specimen.

* Kayser, Zeitschr. deut. geol. Gesell., vol, xlix, 1897, p. 287, t. x, fig. 9.

† Knod, Neues Jahrb. f. Miner. Geol., Beil. Bd. xxv, 1908, p. 503, t. xxii, figs. 1–2*b*.

‡ Williams and Breger, *op. cit.*, p. 270, pl. xiv, figs. 3–10, 16, 21.

§ Clarke, *op. cit.*, 1913, p. 174, pl. ix, fig. 7.

‖ Clarke, Mem. 9, New York State Mus., pt. 1, 1908, p. 153, pl. xvii, figs. 25–28.

¶ Clarke, Archiv Mus. Nac. Rio de Janeiro, 1899, p. 34, pl. iii, figs. 1–4.

** Thomas, Zeitschr. deut. geol. Gesell., vol. lvii, 1905, p. 251, t. xii, figs. 12, 12*a*.

Orthoceras bokkeveldense, Reed.

1904. *Orthoceras bokkeveldensis* Reed, Ann. S. Afr. Mus., vol. iv, pt. 6, p. 239, pl. xxx, fig. 2 (172 S.A. Mus.).

Knod * considered Ulrich's *Orthoceras* sp. γ from Bolivia as identical with *O. bokkeveldense*, and if so *O. Ulrichi* Kozl.,† which is the name proposed for it by Kozlowski, is likewise, but Kozlowski denies this identification because the siphuncle is central. *O. Steinmanni* Kozl.,‡ also from Bolivia, which is said to be closely allied to *O. Ulrichi*, may also be compared.

Orthoceras gamkaense, Reed.

1904. *Orthoceras gamkaensis* Reed, Ann. S. Afr. Mus., vol. iv, pt. 6, p. 239, pl. xxx, figs. 1, 1*a* (177, 178 S.A. Mus.).

Kozlowski § has recently compared a Bolivian form with this species, and it is probable that they are identical, the slight want of circularity in section in my original specimens being due to distortion. Clarke ‖ in 1913 had also compared a Brazilian specimen with it.

Orthoceras (*Spyroceras ?*) *rex*, Schwarz.

1906. *Orthoceras rex* Schwarz, Rec. Albany Mus., vol. i, pt. 6, p. 381, pl. viii, fig. 7 (2812 Alb. Mus.).

In the concentric annulation and other characters of this species we see a great resemblance to *O. san-bartolomense* Kozl.¶ of the Devonian of Bolivia; indeed it may be identical. It is less like the large variety of *Kionoceras rhysum* Clarke ** from the Grande Grève Limestone of Quebec, and it has no longitudinal ribs.

There is only the one poor specimen (2812 Alb. Mus.) of this species which was found on Keurbooms River heights, Knysna. Schwarz does not describe, though he names the species, so that some remarks on its characters may be here given. The shell is annulated, and has gently concave spaces between the rings which are horizontal, low, and situated at about two-fifths or one-third of the diameter apart. The septa do not show distinctly, but seem to coincide with the rings. The specimen is crushed, but the rate of tapering was undoubtedly very slow (1 in 16–17, as Schwarz states). Probably it belongs to

* Knod, *op. cit.*, 1908, p. 502.

† Kozlowski, *op. cit.*, 1923, p. 63, pl. vii, fig. 8.

‡ *Ibid.*, p. 64, pl. vii, fig. 10.

§ *Ibid.*, p. 63, pl. vii, fig. 9.

‖ Clarke, *op. cit.*, 1913, p. 159, pl. viii, fig. 10.

¶ Kozlowski, Ann. Paléont., vol. xii, 1923, p. 65, pl. vii, figs. 14, 15.

** Clarke, Mem. 9, New York State Mus., pt. 1, p. 142, pl. xiii, figs. 4, 5.

the subgenus *Spyroceras* Hyatt, of which *O. crotalum* (Hall) of the Hamilton Formation * is a well-known example.

Tentaculites Baini, Reed.

1904. *Tentaculites Baini* Reed, Ann. S. Afr. Mus., vol. iv, pt. 6, p. 246, pl. xxx, fig. 9 (181 S.A. Mus.).

No further example of this species has been found. Clarke † does not think that it is justifiable to compare it with his *T. jaculus*, but the author pointed out its resemblance in some respects to *T. eldredgianus* Hartt and Rathbun, and it may further be stated that it bears considerable similarity to *T. Cartieri* Clarke,‡ from the Gaspé basin, Quebec.

Tentaculites crotalinus, Salter.

1904. *Tentaculites crotalinus* Reed, Ann. S. Afr. Mus., vol. iv, pt. 6, p. 245 (for earlier references).

1913. *Tentaculites crotalinus* Clarke, "Foss. devon. Parana," p. 86, pl. viii, figs. 1–4.

1913. *Tentaculites crotalinus* Kozlowski, Ann. Paléont., vol. viii, p. 11, pl. xii, figs. 15, 15*a*.

The relations of this species were discussed by me in 1904, and Clarke has more recently described it in connection with the South American fauna, recording it from Brazil and the Falkland Islands, while Kozlowski figures it from Bolivia. It is widely distributed in the Bokkeveld Beds.

Tentaculites desuetus sp. nov.

(Pl. VII, figs. 9, 10.)

Shell elongated, conical, tapering slowly at about 1 in 8 or 9 to apex, annulated for the greater part of its length with sharp regular equidistant rings, separated by concave interspaces of 3–4 times the width, but with the apical portion of the shell devoid of rings and smooth. Interspaces ornamented with fine equidistant regular longitudinal lines.

Dimensions (135 Cape Univ.): Length, *c.* 26·0 mm.; Diameter at mouth, *c.* 3·5 mm.

Remarks.—There is a good specimen of this shell from Keurbosch (135) in the collection of the University of Cape Town, though it is

* Prosser and Kindle, Maryland Geol. Surv., Mid. Devonian, 1913, p. 314, pl. xli, figs. 1–5.

† Clarke, *op. cit.*, 1913, p. 89.

‡ Clarke, Bull. 107, New York State Mus., 1907, p. 174, text-figs.

somewhat crushed and flattened; the smooth apical portion measures in this case nearly one-third of the total length, but usually it is shorter in other examples from this locality (291, 293 Cape Univ.). Another group of specimens (446 Pret. Mus.) from Tunnel Siding, near Triangle, is in the Pretoria Museum. The rings are not oblique to the axis nor at unequal distances apart, as in *T. Stübeli* Clarke,* from Brazil and Bolivia, which it otherwise closely resembles in having the apical portion smooth and not annulated. The longitudinal lineation of the interspaces which is rarely preserved is another point of difference. The Helderbergian species, *T. elongatus* Hall, which also occurs in the Oriskany, is described by Clarke † as losing its annulations towards the apex, as in our Bokkeveld form.

Serpulites sica, Salter.

1856. *Serpulites sica* Salter, Trans. Geol. Soc., ser. 2, vol. vii, p. 22, pl. xxv, fig. 19.

1913. *Serpulites sica* Clarke, "Foss. devon. Parana," p. 86, pl. xxvi, fig. 15.

Clarke (*op. cit.*) has described this Bokkeveld species from Brazil, but can add nothing to the original description. Probably the fossil from the Chapman Sandstone, Maine, described by Williams and Breger ‡ as *Trachyderma* (? *Gyrichnites*) *speciosa* sp. nov. is congeneric and an allied species.

TRILOBITA.

Proetus malacus, Lake.

(Pl. XI, fig. 3.)

? 1888. *Praetus* (sic) *ricardi* Schenck, Peterm. Mitth., vol. xxxiv, p. 227.

1904. *Proetus malacus*, Lake, Ann. S. Afr. Mus., p. 213, pl. xxv, fig. 10 (45 S.A. Mus.).

1906. *Proetus ricardi* Schwarz, Rec. Albany Mus., vol. i, pt. 6, p. 390, pl. x, figs. 5, 5*a*.

Lake's type specimen (45 S.A. Mus.) is not in a very good state of preservation, and it is therefore satisfactory to find a complete, partly-enrolled example from the Cockscomb Mountains in the Bloemfontein Museum, from which several additional details may be

* Clarke, Archiv Mus. Nac. Rio de Janeiro, vol. x, 1899, p. 43, pl. iv, figs. 24–28; Knod, Neues Jahrb. f. Miner. Geol., Beil. Bd. xxv, 1908, p. 559.

† Clarke, Mem. 3, New York State Mus., 1900, p. 27, pl. iii, figs. 8–12.

‡ Williams and Breger, *op. cit.*, 1916, p. 19, pl. xxii, fig. 20.

given. The glabella has three pairs of furrows on it; the first pair are short, horizontal, slightly arched, scarcely reaching the axial furrow, and situated at about one-third the length of the glabella from the front end; the second pair are more oblique and longer, extending more than one-third across the glabella, and are situated at about one-half its length; the third pair are more oblique and curve back to meet the meso-occipital furrow separating off the basal lobes, which are larger than the others, and triangular in shape, with their base equal to one-third the width of the glabella. The glabella is sub-urceolate, very broad and short, widening rather rapidly towards the base behind the second lateral furrows. The eyes are very large, closely placed against the sides of the glabella, and reach from the first lateral furrows to its base. As Lake states, the axial furrows are weak, but particularly so in crossing the eye-lobes. The genal angles are produced back into broad, flattened, rapidly-tapering genal spines, reaching back to the sixth or seventh thoracic pleurae. The meso-occipital furrow is strong, deeply impressed, and narrow, and is slightly arched forward in the middle. The pleuro-occipital furrow is wide and shallow. The marginal and pleuro-occipital furrows meet at a very acute angle at the base of the genal spines, and are produced back to their tip, grooving the spines for their whole length.

The glabella reaches the broad, flattened, or slightly-concave border in front and descends rather steeply to it.

The thorax has 9 segments and is convex and wider than the pleural lobes, as Lake says, and the pleurae have been described by him.

The pygidium is large and possesses 7 rounded elevated unfurrowed pleurae, which are separated by interpleural grooves as wide as the pleurae, and they reach the narrow raised rounded border, which is marked off by a wide marginal furrow. The whole surface of the trilobite is covered with rather coarse granulation.

Dimensions:—

Length of head-shield	15·0 mm.
Width ,, ,,	30·0 ,,
Length of glabella	10·5 ,,
Width ,, ,, at base	11·5 ,,
,, ,, ,, at front	9·0 ,,
Length of thorax	*c.* 18·0 ,,
,, of pygidium	*c.* 15·0 ,,
Width ,,	25·0 ,,
,, of axis of pygidium	10·0 ,,

Affinities.—The species may be referred to the subgenus *Euproetus*, established by Richter * in 1913, and it seems allied to *Proetus conradi* Hall † of the early Devonian of North America, and especially to *Pr. phocion* Billings,‡ from the Grand Grève Limestone of Gaspé.

Proetus hexensis sp. nov.

(Pl. VII, fig. 8.)

Pygidium broadly semicircular, very slightly arched; margin entire. Axis broadly conical, gently convex, tapering rather rapidly to blunt tip, not reaching edge, annulated for whole length very indistinctly by 8–9 low, broad, flattened, very faintly-defined rings, of which only the anterior 2–3 have sharp intersegmental furrows. Pleural lobes slightly convex, with half pleura on front margin having obtusely-angular, well-marked fulcrum at about half its width, and strong sharp furrow behind it; rest of pleural lobes composed of 5 very flat low pleurae, of which only the first 2–3 are distinct, being separated by narrow sharp furrows not reaching border, and having a faint furrow on their surface parallel and close to anterior edge. Border of pygidium slightly flattened, very feebly marked off from pleural lobes. Surface of pygidium minutely granulated.

Dimensions (H 176 Stell. Mus.) :—

Length of pygidium . .	16·0 mm.
Width ,, ,, . .	30·0 ,,
Length of axis . . .	14·0 ,,
Width ,, ,, at front . .	11·0 ,,

Remarks.—The specimen above described is from De Doorns and is in the Stellenbosch Museum. A smaller example (3889 S.A. Mus.) in the South African Museum comes from Uitkomst, Ceres. This type of pygidium is more like that of *Proetus Rowi* (Green) § of the Hamilton Formation than *Pr. malacus*, but we may observe a resemblance in it to *Phacops? pullinus* Clarke ‖ from Brazil, which its author thought might belong to the genus *Proetus*.

* Richter, Abh. Senckenberg. Naturforsch. Gesell., Bd. xxxi, 1913, p. 352; *id.*, Centralbl. f. Min., etc., Jahrg. 1918, pp. 64–70.

† Hall, Palaeont. New York, vol. vii, 1888, p. 89, pl. xx, fig. 9; pl. xxi, figs. 27, 28; pl. xxii, fig. 4; Clarke, Mem. 3, New York State Mus., 1900, p. 25, pl. ii, figs. 11–16.

‡ Clarke, Mem. 9, New York State Mus., pt. i, 1908, p. 135, pl. ix, figs. 14–16.

§ Hall, Palaeont. New York, vol. vii, 1888, p. 119, pl. xxi, figs. 2–6, 24–26, pl. xxiii, figs. 20–29.

‖ Clarke, Archiv Mus. Nac. Rio de Janeiro, vol. ix, 1890, p. 20, pl. i, fig. 12.

Cyphaspis Dereimsi, Kozlowski.

(Pl. X, fig. 10.)

1923. *Cyphaspis Dereimsi* Kozlowski, "Faune Devon. Bolivie," Ann. de Paléont., vol. xii, p. 61, pl. iv, figs. 15, 16, 17, 17*a*.

One nearly complete individual possessing the characteristic features of the Bolivian *Cyphaspis Dereimsi* Kozlowski, was obtained by me in the road-cutting between De Doorns and Tunnel. The head-shield and thorax are excellently preserved both as the cast and impression, and the former shows well the glabella with its pair of basal lobes, the convex preglabellar area and wider border, as well as the eyes, facial suture, and genal angle on one side. The pygidium is missing. Kozlowski compares this species with *C. minuscula* Hall,* of the Onondaga and Oriskany Groups, but it is certainly distinct.

No example of this genus has been previously discovered in the Bokkeveld Beds, and this occurrence is another valuable piece of evidence of the close similarity of the South American and South African Devonian faunas.

Dimensions :—

Length of head-shield . . .	11·0 mm.
Width ,, ,, . .	24·0 mm.
Width of glabella . . .	8·0 mm.

Dalmanites (*Anchiopella*) *africanus* (Salter) sens. restr.

(Pl. VIII, figs. 1, 1*a–c*.)

1856. *Phacops* (*Cryphaeus*) *africanus* Salter (pars), Trans. Geol. Soc., ser. 2, vol. vii, p. 218, pl. xxv, fig. 1 (11295 Brit. Mus. ?), fig. 5 (11287 Brit. Mus.) (*non cet.*).

1904. *Phacops cristagalli* Lake (*non* Woodward), Ann. S. Afr. Mus., vol. iv, pt. 4, p. 205, pl. xxiv, fig. 5 (27 S.A. Mus.).

1904. *Phacops africanus* Lake, *ibid.*, p. 205, pl. xxiv, fig. 6 (67 S.A. Mus.), fig. 7 (27 S.A. Mus.), fig. 8 (222 S.A. Mus.).

1906. *Phacops acacia* Schwarz, Rec. Albany Mus., vol. i, pt. 6, p. 398, pl. x, figs. 4, 4*a* (2124 Alb. Mus.).

1913. *Dalmanites* (*Mesembria*) *acacia*, Clarke (pars), "Foss. devon. Parana," p. 116, pl. v, figs. 7, 8 (? 5, 6, 9).

The primary difficulty in determining the true characters of *Ph.*

* Hall and Clarke, Palaeont. New York, vol. vii, 1888, p. 140, pl. xx, fig. 17; pl. xxiv, figs. 7–12; Clarke, Mem. New York State Mus., No. 3, vol. iii, 1900, p. 24, pl. ii, figs. 24, 25.

africanus of Salter lies in the uncertain identification of the first specimen figured by Salter under this name. Lake, though largely successful in sorting the somewhat heterogeneous collection assembled by Salter under this name, felt doubtful about the type. But it may be regarded as fairly certain that the poor specimen in the British Museum, numbered 11295, from Leo Hoek, was the one from which Salter's partially restored figure was drawn, and it may have been that the specimen was subsequently somewhat damaged. It consists of a head-shield with part of the thorax attached, and the glabella shows the same characters of lateral furrows, etc., as in a similarly-preserved, nearly-complete individual (5420 S.A. Mus.) from Welvereden, Prince Albert, in the South African Museum, the depth of the basal furrows contrasting strongly with the weakness of the first and second furrows; the anterior end of the glabella is imperfect in both cases, but it seems to have been bluntly rounded. From Salter's poor specimen alone, assuming that No. 11295 in the British Museum is his figured type, we could hardly give a satisfactory definition of the species, but the Welvereden example, together with a beautiful thorax and pygidium preserved in a nodule as an internal cast and external impression in the Cape University Museum (321*b*, 321*c*) from the Hex River Valley (see below), allow us to clear up some uncertain points.

Clarke,* under the mistaken idea that Salter's *Ph. africanus* should be placed in *Cryphaeus*, expressed the view that Lake's specimens (67, 27, 222 S.A. Mus.) from Gamka Poort, figured as *Ph. africanus*, do not belong to Salter's species, though he stated that Salter's figure 1 (11295 Brit. Mus.) "makes an entirely normal accompaniment to the true *Cryphaeus* represented in his fig. 4." Ulrich † regarded his Bolivian species *Cryphaeus convexus* as much resembling *Ph. africanus*, but Knod ‡ puts Ulrich's species in the genus *Acaste*.

Schwarz (*op. cit. supra*) established a species *Ph. acacia* for a certain form having a nuchal spine, a series of spines on the thoracic axis, and a subtriangular pygidium with a simple margin and no spines on the axis; but he was of the opinion that Salter's name, *Ph. africanus*, might have to be restored and the name *acacia* dropped. The new evidence which we now possess proves that Schwarz was right. Clarke, however (*op. cit.*), tried to establish Schwarz's species under his name on a firmer basis, but though the thorax and pygidium (*op. cit.*, figs. 7, 8) from the Falkland Isles which he figures are un-

* Clarke, *op. cit.*, 1913, pp. 112, 113, 129.

† Ulrich, Neues Jahrb. f. Miner. Geol., Beil. Bd. viii, 1893, p. 16, t. i, figs. 9–11.

‡ Knod, *ibid.*, Beil. Bd. xxv, 1908, p. 499, t. xxi, fig. 4.

doubtedly identical with Schwarz's *Ph. acacia* and with Lake's *Ph. cristagalli* (which Schwarz had pointed out was distinct from Woodward's *Encrinurus cristagalli*), the head-shields which Clarke figures (*op. cit.*, figs. 5, 6, 9) from the same region do not precisely agree with Salter's true *Ph. africanus* nor with Schwarz's *Ph. acacia*. We may here notice that Schwarz correctly recognised that one of the head-shields figured by Salter under the name *africanus* (*op. cit.*, pl. xxv, fig. 5, 11287 Brit. Mus.) was referable to the type of thorax with a median spine on each axial ring; and the meso-occipital ring has a corresponding nuchal spine, which is seen in all well-preserved examples of *D. africanus*.

Of Salter's other figures we may here state that the specimen of a thorax and pygidium (11284) from Gydo Pass represented in his second figure (*op. cit.*, pl. xxv, fig. 2) undoubtedly belongs to a species of *Calmonia* (*q.v.*), and not to a species of *Anchiopella*, as Clarke himself remarks. So that we should have to transfer the specific name *africanus* to this second specimen if we regard Salter's first figure as valueless owing to the doubtful identification of the specimen. Further remarks on this point are made below. Lake, however, though not referring to Salter's fig. 2, pursues the right course and figures specimens which undoubtedly belong to the only rational interpretation of Salter's species, and the first specimen which Lake figures (fig. 6) (67 S.A. Mus.) is the one to which his detailed diagnosis of the species applies. The weakness of the first and second pairs of glabellar furrows, and the strength of the third pair are noticeable features, the second furrows not reaching the axial furrows; the frontal lobe is obtusely angulated; the nuchal spine is not preserved in this specimen (though Lake correctly states there is one present in the species), because the middle part of the occipital ring is broken; Lake says that the genal angles are produced into short points, but they are also imperfect, and we can only say that they may have been bluntly pointed. There is no clear trace of any median spines on the thoracic axis in this specimen, though Lake believes that they were present. The margin of the pygidium (which is subparabolic rather than triangular in outline as described) is entire; the swollen elevated axis apparently projects somewhat behind, but there is no clear evidence of a terminal mucro.

In the other specimen (27 S.A. Mus.) figured by Lake (*op. cit.*, fig. 7) it is important to observe that this head-shield is on the same small piece of rock as his figured example of a thorax and pygidium of *Ph. cristagalli* (*op. cit.*, fig. 5), and occurs in close association, for our

fresh evidence proves that they belong to one and the same species. The head-shield is poorly preserved, except the eyes, which show about 20 rows of lenses, and are much elevated on swollen conical bosses opposite the second glabellar furrows. The cheeks seem to be bluntly pointed. The development of the glabellar furrows seems to be much the same as in the other figured specimen.

In the British Museum there is a complete partly-enrolled specimen (I 4047) from the Cedarberg, in which we can see the characters of the head-shield well preserved. The pentagonal glabella is obtusely angulated in front; the first and second lateral furrows are weak in comparison with the third lateral or basal furrows, which are strong, as in Lake's figured specimen (*op. cit.*, fig. 6 [67 S.A. Mus.]). The doublure and front part of the head-shield are excellently preserved in this British Museum specimen; the rostral doublure is obtusely triangular, bluntly pointed in the middle, convex and upturned; the edges meet in the middle at an angle rather greater than a right angle; and behind the rather wide rounded marginal portion of the doublure, or rostral shield, there is a median depressed triangular area. There is no rostral spine projecting in front. The genal angles are in this specimen broken off as usual, but the eye-lobes are well preserved and have the elongated shape and degree of upturning seen in one of Salter's figured specimens of *Ph. africanus* (11287 Brit. Mus., *op. cit.*, pl. xxv, fig. 5), in which, however, the glabellar furrows are more strongly and equally developed. The eyes are large, prominent, and have a high vertical lens-bearing surface. The lenses on the left eye are nearly perfect and are arranged in 22–24 vertical rows, having 7–8 lenses in the middle rows; the lenses are not in contact, but have small granules between them. The rostral doublure in our specimen (I 4047) is rather more finely granulated than the rest of the head-shield. The nuchal spine, as also in Salter's specimen, is well seen, and the thorax has the characters of *Ph. acacia*, showing the traces of the median spines on the axial rings quite distinctly, and the broad flattened anterior bands for enrolment on each axial ring are excellently displayed. The pygidium has the characters of Lake's *Ph. africanus*, the axis being very convex with a projecting tip. The whole surface of the head-shield is granulated; on the glabella the granulation is rather coarse, and on the free cheeks there are a few small oval pits arranged radially with some regularity on the outer slope below the eye, each pit being surrounded with a ring of granules. The thorax is also covered with closely-set granules, but not all of the same size.

Schwarz described the head-shield of his *Ph. acacia,* basing it on a very poor specimen (locality unknown) associated with the thorax and pygidium (2124 Alb. Mus.), and he described and figured it as having genal spines of a peculiar kind which Clarke does not show in his figures of head-shields attributed to the same species from the Falkland Isles. The head-shield, however, which Schwarz describes is only an impression, and is really better than his scanty figure indicates, though the genal spines, which are the important distinction, are not clearly distinguishable. The frontal lobe of the glabella is, however, visible, and is angulated in front ; the first and second lateral furrows are weak, as usual, while the basal ones are deep ; the eyes are prominent, and the whole surface of the head-shield is finely granulated. But, as is remarked below, Schwarz's figure closely agrees with the form here separated from *D. africanus* under the name *D. Baini.* There are many examples of detached head-shields undoubtedly referable to Salter's species in museums in South Africa (116, 17 Port Elizabeth), (1424, 1425 Alb. Mus., Bain Coll.), (H 75 Stell. Mus.), but in all cases the genal angles are imperfectly preserved. There is the internal cast of a nearly complete specimen in the South African Museum (5420 S.A. Mus.) from Welvereden, Prince Albert, having the head, thorax and pygidium nearly perfect, but only a few of the axial rings show the broken base of the spines. This specimen possesses in every respect the characters of that supposed to be Salter's fig. 1 of *D. africanus* in the British Museum (11295 Brit. Mus.), and the eye is well preserved and shows the large separated lenses alternating in adjacent rows as in the other better-preserved example in the British Museum (I 4047 Brit. Mus.) above described. The thorax and pygidium of the Welvereden specimen completely agree with the beautifully-preserved natural cast and impression of a thorax and attached pygidium (321*a*, *b*) in the Cape University Museum from the Hex River Valley, of which the cast in the British Museum made from this impression shows the upstanding axial spines on the thorax in a perfect condition, and it is precisely identical with Lake's *Ph. cristagalli* from Gamka Poort, and with Clarke's *Ph. acacia* from the Falkland Isles. The pygidium is not produced into a terminal mucro or spine, but ends in a blunt point behind the prominent convex cylindrical axis. The outline of the pygidium is characteristic, for the sides are somewhat excavated, the posterior part tapering less rapidly than the anterior, and the pleural lobes more strongly bent down near the tip. Clarke states that *D. acacia* had a " more extended caudal spine " than his *D. falklandicus,* which has a very

similarly-shaped pygidium, but his figures do not show it, and *D. africanus* has no definite mucro.

The name *Anchiopella* was suggested by the author * in 1907 for the subgenus of *Dalmanites*, comprising *D. cristagalli*, *D. acacia* [=*africanus* Salter *sens. restr.*], and *D. arbuteus*. Clarke † adopts it as a group name, and so does Kozlowski ‡ who credits Clarke with the name and uses it in a subgeneric sense, as is done here.

Dalmanites (*Anchiopella*) *cristagalli* (Woodward).

1873. *Encrinurus cristagalli* Woodward, Quart. Journ. Geol. Soc., vol. xxix, p. 31, pl. ii, figs. 6, 7.

? 1904. *Phacops arbuteus* Lake (pars), Ann. S. Afr. Mus., vol. iv, pt. 4, p. 203, pl. xxiv, fig. 4 (40 S.A. Mus.), *non cet.*

1906. *Phacops cristagalli* Schwarz, Rec. Albany Mus., vol. i, pt. 6, p. 392, pl. x, fig. 6.

Schwarz pointed out the differences between this species and *D. acacia*, and further remarks on it have been made above. Lake's figured specimen of *Ph. cristagalli*, as above stated, is identical with *Ph. acacia*, and distinct from Woodward's type, which came from the Cockscomb Mountains. One of the unnamed specimens of *Phacops* in the British Museum (48774) from Rozendal shows part of a pygidium with the coarse tubercles of *D. cristagalli*; otherwise I have not detected any other example of the species. Lake remarked on the close relationship of *D. arbuteus* and *D. cristagalli*, particularly in the tuberculation of the head (though Woodward's species was founded on a pygidium), but his association of the differently ornamented pygidium with the head-shield of *D. arbuteus* led him to separate them. In the new description given below by me of his first figured specimen of *D. arbuteus* (64 S.A. Mus.), which is a head-shield, the fact that both species at any rate belong to the subgenus *Anchiopella* is emphasised, and their separation must be left an open question. It is probable that the pygidium (40 S.A. Mus.), with the terminal spine referred by Lake to *D. arbuteus*, should be placed in *D. cristagalli*. Lake remarked on its similarity, and it lacks the coarse tuberculation, which is a marked feature of the head of *D. arbuteus*.

D. cristagalli differs from *D. africanus* in the presence of a few coarse rounded tubercles on the pleurae of the pygidium, and, as

* Reed, Geol. Mag. N.S., Dec. v, vol. iv, 1907, p. 168.

† Clarke, *op. cit.*, 1913, pp. 147, 148, 154.

‡ Kozlowski, *op. cit.*, 1923, pp. 33, 35, 51.

remarked below, the head-shield on which Lake founded his *D. arbuteus* may belong to it.

Dalmanites (*Anchiopella*) *arbuteus,* Lake (pars).

1904. *Phacops arbuteus,* Lake (pars), Ann. S. Afr. Mus., vol. iv, pt. 4, p. 203, pl. xxiv, fig. 2 (64 S.A. Mus.), *non* figs. 3, 4.

The head (64 S.A. Mus.) which Lake figured as the type of this species is much crushed and distorted, so that its real shape and characters are difficult to determine. But Lake's description is hardly adequate, and he seems to have attempted to include the characters of the other glabella (61 S.A. Mus.) which he figured (*op. cit.*, fig. 3) as belonging to it. The glabella appears to have been subpentagonal, and as wide as long, and has three pairs of well-defined lateral furrows extending inwards more than one-third across it; the anterior furrows seem to arise rather far back, *i.e.* at about half the length of the glabella, and are directed obliquely backwards, so that the frontal lobe must have been large; the second and third furrows are horizontal and subparallel. The basal lobes are very small. There is a certain definite arrangement of the tubercles on the surface, and they are unusually coarse and form short conical spines; there are two median longitudinal rows of them down the middle of the glabella, and the posterior five or six are arranged in pairs, but the anterior ones are less regular; there are similar large tubercles on each side, and each lateral lobe bears one or two. The meso-occipital ring has a short stout median nuchal spine. The cheeks are too imperfect for description, but the head-shield seems to have measured about 28–30 mm. in length, and the glabella about 23–24 mm. in width.

As Lake remarks, the coarse tuberculation suggests *D. cristagalli*, but we have no means of connecting the two species as they are based respectively on an isolated head-shield and an isolated pygidium from different localities. For the pygidium attributed by Lake to *D. arbuteus* (*op. cit.*, fig. 4) (40 S.A. Mus.) is quite differently ornamented, and the glabella (61 S.A. Mus.) (*op. cit.*, fig. 3) is also distinguished by the absence of the coarse spinose tubercles of the type specimen.

The only other specimen which I have seen that can be referred to *D. arbuteus* is a fragmentary head-shield (3884 S.A. Mus.) from Hottentot's Kraal, Ceres, showing the characteristic coarse tuberculation.

An imperfect head-shield from Bolivia, showing only a portion of a

glabella and the meso-occipital ring with nuchal spine, has been compared by Lake * with his *D. arbuteus*, and it obviously belongs to *Anchiopella*, though the species is doubtful.*

We may perhaps compare the Bolivian *Anchiopella Haugi* Kozl.† with *D. arbuteus* (sens. restr.), especially on account of the tuberculation and short broad glabella, and the glabellar furrows seem to be somewhat similarly developed.

Dalmanites (*Anchiopella*) *Baini* sp. nov.

(Pl. IX, figs. 1–3.)

? 1856. *Phacops africanus* Salter (pars), Trans. Geol. Soc., ser. 2, vol. vii, p. 218, pl. xxv, fig. 3 (*non cet.*) (11285 Brit. Mus.).

Head-shield transversely semicircular, distinctly angulated in front at 130°–140° in a broad subogival point. Glabella broadly pentagonal, more than one-third the width of the head-shield, expanding gradually in width anteriorly, not swollen ; sides straight, anterior end obtusely angulated ; first lateral furrows placed far forward, arising a very little behind the lateral angles of the frontal lobe, long, straight, obliquely directed backwards, extending inwards about two-fifths the width of the glabella on each side ; second lateral furrows gently arched or straight, less oblique, extending inwards as far as first furrows, but faintly or scarcely connected with axial furrows ; third lateral furrows horizontal, nearly straight, slightly curved forwards at outer ends, deeper and stronger than second furrows, but as long and connected completely with axial furrows at sides ; meso-occipital furrow deep, gently arched forwards. Frontal lobe of glabella short, broad, transverse, about twice as wide as long ; second and third lateral lobes only faintly separated near axial furrow owing to weakness or obsolescence of outer ends of second lateral furrows. Meso-occipital ring rounded, bearing short stout median upstanding cylindrical spine. Anterior border of head-shield in front of glabella very narrow, rounded, separated off by strong continuous furrow. Facial sutures with anterior branches straight and parallel, and with posterior branches bending out at right angles behind eyes and running nearly straight and horizontally direct to marginal furrow, curving back sharply on crossing broad lateral border. Cheeks slightly swollen. Pleuro-occipital furrow strong, horizontal, nearly straight, meeting

* Lake, Quart. Journ. Geol. Soc., vol. lxii, 1906, p. 428, pl. xl, fig. 8.

† Kozlowski, *op. cit.*, 1923, p. 51, pl. ii, figs. 11–14.

marginal furrow at about 75°. Genal angles not produced, sub-rectangular, armed with short sharp subcylindrical spine directed straight backwards and situated rather inside outer angle, which is subtruncate. Eyes elevated, rather large, slightly oblique, extending back from level of first to third lateral furrows, with anterior end nearly touching glabella. Free-cheeks with broad shallow marginal furrow separating off rather wide gently convex border. Surface of head-shield covered with numerous closely-placed, small, low, rounded, irregularly-disposed pustules.

Thorax with broad strongly-convex axis bearing short vertical spine; pleurae gently arched down, strongly furrowed. Whole surface of thorax coarsely pustulated like head-shield. Pygidium triangular ? mucronate, and with broad cylindrical prominent convex axis, annulated for nearly whole length with 9–10 rings, having blunt tip not reaching posterior margin; pleural lobes narrow, rather strongly arched down, rapidly decreasing in width posteriorly, composed of 5–6 low, rounded pleurae, with scarcely any trace of pleural furrows.

Dimensions :—

	(Sedgw. Mus.)	(26 S.A. Mus.)
Length of head-shield . .	17·5 mm.	18·0 mm.
Width of ,, . . .	35·0 ,,	38·0 ,,
Length of glabella . . .	14·0 ,,	15·0 ,,
Width of ,, at front .	16·5 ,,	18·0 ,,
,, ,, ,, at base .	11·5 ,,	14·0 ,,

Remarks.—There are two slabs of a rather micaceous greenish flaggy slate in the Sedgwick Museum from an unknown locality, presented in 1906 by the South African Museum, containing portions of 7 head-shields and 2 pygidia of the species. In the South African Museum there is another similar slab and its reverse (7200 S.A. Mus.) containing several head-shields, a pygidium and portions of the thorax, and in the Durban Museum there is a slab of identical lithological character with a head-shield showing the genal angle and a pygidium. It is on these specimens that the above definition is based. But there is also a head-shield (3934 S.A. Mus.) from Hottentot's Kraal in the South African Museum, and another (433 Pret. Mus.) from Boschluis Kloof in the Pretoria Museum, and another (139 Cape

Univ.) in the Cape University collection, which seem to have precisely the same characters.

The general characters of the glabella and head-shield recall *D. falklandicus* Clarke,* and the pygidium is almost identical in character; but the presence of the meso-occipital spine is distinctive, and the pleuro-occipital ring seems to be wider towards the genal angles. Clarke, moreover, does not mention or depict any axial spines on the thoracic segments.

The head-shield is much like that of *D. africanus*, but the glabella is more pentagonal, the two pairs of anterior furrows are stronger and deeper, the eyes are larger, and the ornamentation is much coarser. The genal spines are developed in rather an unusual way, and are well seen in the specimen (181 Cape Univ.) in the collection of the Cape University. Their shape and position are just as in Schwarz's fig. 4, pl. x (*op. cit.*), of the posterior edge of a head-shield attributed to *Ph. acacia*, which, he states, is a composite figure drawn from several casts of fragments. The thoracic segment (11285) in the British Museum, figured by Salter (*op. cit.*, pl. xxv, fig. 3) as belonging to *D. africanus*, may belong to *D. Baini*, and the pygidium from Gamka Poort (222 S.A. Mus.) figured by Lake (*op. cit.*, pl. xxiv, fig. 8), also as *D. africanus*, may be likewise referable to it. The thoracic segments of *D. Baini* seem to have shorter, smaller, axial spines than *D. africanus*, but only isolated and imperfect portions of the thorax are associated on the slabs with the head-shields and pygidia.

Dalmanites (*Corycephalus ?*) *capensis* sp. nov.

(Pl. VIII, figs. 5, 6.)

Head-shield semi-elliptical to semi-circular, gently convex, with the anterior border in front of the frontal lobe of the glabella furnished with a few short blunt denticulations. Glabella large, subpentagonal to subclavate, widening anteriorly, with straight sides and rounded anterior end; frontal lobe large, swollen, transverse, about half the length of the glabella, projecting slightly at sides, with median pit at base; second and basal lobes depressed, small, subequal, transverse; anterior lateral furrows strong, oblique, long; second and third lateral furrows represented by isolated transverse deep horizontal pits, scarcely connected with axial furrows, the third pair better marked. Axial furrows straight, diverging anteriorly. Occipital ring simple,

* Clarke, *op. cit.*, 1913, p. 105, pl. v, figs. 1–4.

well defined by deep furrow; meso-occipital furrow arched forward gently in middle; pleuro-occipital furrow wide, deep, meeting marginal furrow at about 60°. Pleuro-occipital ring rounded, widening slightly to genal angles. Lateral border raised, rounded, defined by definite furrow, wider and shallower than pleuro-occipital. Genal angles sharply rounded, not produced back. Facial sutures with posterior branch curving forward strongly in its outward course and then arching back to cut lateral edge some distance in front of genal angles. Eyes large, sharply bent, reaching from first to third lateral furrows, nearly touching axial furrows at front end, composed of 24–26 vertical rows of lenses. Eye lobe depressed, with swollen edge. Surface of glabella and border coarsely granulated. Cheeks covered with large, low, closely-placed, rounded tubercles, especially towards genal angles. Doublure in front ornamented with triangular group of similar tubercles; rest coarsely granulated.

Dimensions:—

	(216 Cape. Univ.)	(H 76 Stell. Mus.)
Length of head-shield . .	18·0 mm.	29·0 mm.
Width of ,, . .	40·0 ,,	*c.* 62·0 ,,
,, glabella at base . .	11·0 ,,	18·5 ,,
,, ,, across frontal lobe	17·5 ,,	28·0 ,,
Length of glabella . . .	16·0 ,,	26·0 ,,

Remarks.—There is one fairly-well preserved head-shield (H 76 Stell. Mus.) in the Stellenbosch Museum from Klein Straat Station, with three thoracic segments attached, but the whole specimen is rather crushed. The axis of the thorax is broad, and there are lateral swellings on each ring; the pleurae have a rather strong but rounded fulcrum at about half their length, and a deep, gently-sigmoidal, diagonal furrow. The marginal projections on the front of the head-shield are indistinctly seen.

The other specimen is a better head-shield (216 Cape Univ.) in the collection of the Cape University from Touws River Road. It shows clearly the marginal denticulations of the border in front of the frontal lobe, and is not much crushed; the peculiar ornamentation of the cheeks and median part of the doublure is well preserved, the rest of the surface of the head-shield being only coarsely and uniformly granulated.

This species is allied to *D. Drevermanni* Thomas * (non *Cryphaeus*

* Thomas, Zeitschr. deut. geol. Gesell., vol. lvii, 1905, p. 247, t. xi, figs. 1–3.

Drevermanni Richter, 1909) of the Devonian of the Argentine, and to *D. Boehmi* Knod * of Bolivia, especially its variety *boliviensis* described by Kozlowski.† It marks an early stage of the development of the denticulated or crenulated border of *Corycephalus*, and the same stage is seen in the North American Lower Devonian species, *D. stemmatus* Clarke,‡ *D. Dolbeli* Clarke,§ and others, as Clarke ‖ has pointed out. If a distinctive subgeneric name is required for this group of species we may suggest *Eocorycephalus*.

The head-shields of *D. capensis* and *D. caffer* are difficult to distinguish when the anterior margin and ornamentation are not preserved, as the glabella and general characters seem to be identical.

Dalmanites (*Hausmannia*) *Dunni* sp. nov.

(Pl. XI, fig. 5.)

1904. *Dalmanites* sp. Lake, Ann. S. Afr. Mus., vol. iv, pt. 4, p. 212, pl. xxv, fig. 7 (38 S.A. Mus.).

The fragmentary pygidium from Gamka Poort (38 S.A. Mus.), which Lake briefly described and figured without a specific name, deserves further mention. The whole pygidium is flattened and apparently broadly semilanceolate in outline, and probably pointed behind; the pleural lobes are flat and horizontally extended, and the portion of the left one which is preserved shows 10–11 simple pleurae which are flat and do not possess any pleural furrow; the interpleural grooves are sharp and deep. The pleurae diverge backwards and outwards from the axis and curve gently back, becoming more and more directed backwards; the last one is parallel to the axis. There are 10–11 pleurae preserved, of which the last 7 correspond to the axial rings, and probably this is the case also with the anterior ones, but the front part of the axis is missing. The axis is very elongated and conical, tapering very slowly, and shows 16–18 incomplete rings, the interannular grooves being very faint or obsolete across the middle. The whole surface is ornamented with rather coarse regular granulation. The actual margin of the pygidium is not preserved, but the

* Knod, Neues Jahrb. f. Miner. Geol., Beil. Bd. xxv, 1908, p. 508, t. xxi, fig. 1.

† Kozlowski, *op. cit.*, 1923, p. 36, pl. ii, fig. 1.

‡ Clarke, Mem. 3, New York State Mus., 1900, p. 15, pl. i, figs. 6–16; pl. ii, figs. 1, 2.

§ Clarke, Mem. 9, New York State Mus., pt. 1, 1908, p. 121, pl. viii, figs. 1–7.

‖ Clarke, *ibid.*, p. 134.

length of the portion of the axis preserved is 37 mm., and of the pleural lobe 46 mm., and it may be estimated that when complete the pygidium measured at least 55 mm. Whether it had a terminal mucro or not is uncertain, but it was probably pointed behind. We may compare it with *D. Andii* Kozlowski * from the Devonian of Bolivia, but more especially with *D. Clarkei* Ulrich † from the same country, also founded on a pygidium.

Groth ‡ has compared Clarke's *D. maecurua* from Brazil § and Bolivia ‖ with this unnamed species of the Bokkeveld Beds figured by Lake, but Kozlowski (*op. cit.*) doubts if Knod's Bolivian specimen with its incomplete axial rings is referable to Clarke's *D. maecurua*, and Steinmann's ¶ examples from the Cordillera Real are attributed by Kozlowski to a new species, *D. Andii*, while Groth's Brazilian specimen above mentioned is considered to resemble *D. Clarkei* Ulrich ** rather than *D. maecurua*. Knod (*op. cit.*, p. 500) had observed that this South African form as figured by Lake was very similar to the *D. Clarkei* Ulrich from Bolivia. In view of the special peculiarities of our specimen we may give it a distinctive specific name, *Dunni*.

In another larger incomplete specimen, also from Gamka Poort (3949 S.A. Mus.), which probably belongs to the same species, the first six rings at the front end of the axis (which consists of 22–24 segments) are complete, and the posterior ones (16–18 in number) are incomplete across the middle. The last two pleurae arise from the sides of the axis some distance (7 or 8 rings) from its tip ; all of the pleurae end a little inside the margin, as in *D. Clarkei*, with which our species seems undoubtedly most closely allied.

The species undoubtedly belongs to the subgenus *Hausmannia* as used by Hall and Clarke, Etheridge and Mitchell,†† and the author,‡‡ but the obsolescence of the pleurae before reaching the margin of the pygidium is peculiar.

* Kozlowski, Ann. Paléont., vol. xii, 1923, p. 38, pl. ii, figs. 3, 4.

† Ulrich, Neues Jahrb. f. Miner., Beil. Bd. viii, 1893, p. 19, t. i, fig. 13.

‡ Groth, Bull. Soc. Geol. France, ser. 4, vol. xii, 1912, p. 608, pl. xix, fig. 4.

§ Clarke, "Trilob. Grez de Erere, Brazil," Archiv Mus. Nac. Rio de Janeiro, vol. ix, 1890, p. 23, pl. ii, figs. 1–3, 6, 7, 10, 15.

‖ Knod, Neues Jahrb. Miner., Beil. Bd. xxv, 1908, p. 500, t. xxi, fig. 3 ; Lake, Quart. Journ. Geol. Soc., vol. lxii, 1906, p. 429, pl. xl, fig. 11 ?.

¶ Steinmann, Neues Jahrb. Miner., Beil. Bd. xxxiv, 1912, p. 205, t. ix, figs. 1–3.

** Ulrich, Neues Jahrb. Miner., Beil. Bd. viii, 1893, p. 19, t. i, fig. 13.

†† Mitchell, Proc. Linn. Soc. New South Wales, vol. xliv, pt. 2, 1919, pp. 440–446.

‡‡ Reed, Geol. Mag., Dec. v, vol. ii, 1905, pp. 172–178 and 224–228.

Dalmanites (*Hausmannia*) *lunatus*, Lake.

1904. *Dalmanites lunatus* Lake, Ann. S. Afr. Mus., vol. iv, pt. 4, p. 212, pl. xxv, fig. 6 (66 S.A. Mus.).

The one small specimen (66 S.A. Mus.) on which Lake founded this species shows a subclavate glabella widening anteriorly, but the front edge is not preserved. It may also be remarked that the meso-occipital ring is simple and without any spine, and that the pleural lobes of the thorax are flattened and horizontal; the pleurae are nearly straight, with a long, straight, diagonal furrow, and have no distinct fulcrum. The axis of the pygidium is elongated and conical, with 10 complete rings preserved, but most of the pygidium is missing. The species appears to be allied to *Dalmanites patacamayensis* Kozl.* rather than to *D. maecurua*, Clarke † as far as the head-shield, eyes, and thoracic pleurae are concerned, but the pygidium has an axis more like that of *D. Andii* Kozl.‡ The small, broken example which Lake figured measures about 32 mm. in length and the head has a width of about 24 mm. Probably it is a young individual.

Dalmanites (*Hausmannia ?*) sp.

One imperfect head-shield (202 Cape Univ.) from Touws River Road in the Cape University has much the characters of the one figured by Clarke § as *Dalmanites* sp. ind. from Tybagy. The frontal lobe bears near its middle and anterior border an irregular assemblage of rather large, rounded, low tubercles, with a few larger ones amongst them, and there are similar ones on the middle portion of the glabella between the first and second lobes. The other parts of the glabella are merely coarsely granulated, but the tubercles are present again on the free cheeks. *D. accola* Clarke,|| from Ponta Grossa, has similar coarse ornamentation, but the glabella is longer and more clavate in shape instead of subpentagonal. Indeed our specimen has a glabella and lobation apparently identical with *D.* (*Cryphaeus*) *caffer*, as here defined, but the genal angle on the left side, which alone is partly preserved, suggests that it was produced back into a flattened spine rather than merely bluntly pointed, and the frontal lobe of the glabella

* Kozlowski, Ann. Paléont., vol. xii, 1923, p. 36, pl. ii, fig. 2.

† Clarke, *op. cit.*, 1890, p. 23, t. ii, figs. 10–15; Knod, Neues Jahrb. f. Miner. Geol., Beil. Bd. xxv, 1908, p. 500, t. xxi, fig. 3.

‡ Kozlowski, *op. cit.*, p. 38, pl. ii, figs. 3, 4.

§ Clarke, *op. cit.*, 1913, p. 107, pl. iv, figs. 19–21.

|| *Ibid.*, p. 101, pl. iv, figs. 9–18.

is less inflated and there is no evidence of a frontal rostrum. But our specimen is somewhat crushed and the anterior margin is rather broken. The ornamentation and general characters of the head recall *D. phacoptyx* Hall and Clarke * from the Grande Grève Limestone.

Dalmanites (*Proboloides*) *ensifer* sp. nov.

(Pl. VIII, figs. 4, 4*a–d*.)

Head-shield transversely semicircular with a stout, median, flattened, rostral spine projecting in front and slightly upturned; genal angles provided with short, triangular, sharp spines, slightly supragenal, and projecting backwards and a little outwards, not in a line with the lateral margins of the head-shield; posterior margin slightly sigmoidal. Glabella subpentagonal, widening anteriorly, obtusely angulated, but rounded in front; first lateral furrows strong, oblique, long, straight, inclined at very obtuse angle to sides; second lateral furrows horizontal, very weak at outer ends, but deepening inwards into short, transverse pits; third lateral furrows stronger, nearly horizontal, but weak at outer ends. Frontal lobe large, transverse, rather swollen, slightly overhanging at lateral angles, about half length of glabella, with pair of faint, convergent depressions, running inwards a short distance from anterior margin with a V-shape group of large tubercles between them and an outer line of 3–5 similar tubercles on the outer slopes of the frontal lobe, converging inwards towards a median circular pit near its base. Second and third lateral lobes with tendency to fusion at outer ends. Axial furrows strong, straight. Cheeks arched down on each side, triangular, not swollen, sparsely pitted. Facial sutures rather sharply bent in at lateral angles of frontal lobe. Eyes rather small, situated far forward, extending from level of first lateral furrows to slightly behind second lateral furrows of glabella, constricted at base, composed of 26–27 vertical rows of lenses with 8–9 lenses in central rows; eye lobe slightly convex, with groove inside swollen edge. Meso-occipital furrow strong, arched forward in centre, deepest at sides; meso-occipital ring simple, rounded, without spine or tubercle. Pleuro-occipital furrow strong, straight, meeting marginal furrow at about 60°; pleuro-occipital segment widening laterally, smooth. Lateral border of head-shield gently convex above, with sharp outer edge, well defined from cheeks by shallow marginal furrow; border narrowing much in front of

* Clarke, Mem. 9, New York State Mus., pt. 1, 1908, p. 123, text-fig. and pl. vii, figs. 5–10.

glabella. Doublure of head-shield with narrow lateral channelled bands widening anteriorly into flattened, triangular, median plate with weak, rounded, lateral borders and depressed central portion, produced into long upturned rostral spine.

Dimensions (C 2 Stell. Mus.) :—

Length of head-shield to base of rostral spine .	26·0 mm.
Width of ,, at base	50·0 ,,
Length of glabella	22·0 ,,
Width ,, ,, at base	17·5 ,,
,, ,, ,, across frontal lobe . . .	23·0 ,,
Length of frontal lobe	12·0 ,,
,, ,, eye	6·5 ,,
,, ,, genal spine	5·0 ,,
Estimated length of rostral spine . . .	15·0 ,,

Remarks.—The head-shield (C 2 Stell. Mus.) in the Stellenbosch Museum on which this species is founded is complete, except for the anterior part of the rostral spine. The locality at which it was found is unfortunately unknown. The presence of the long rostral spine recalls the *Probolium* * condition and resembles the Brazilian trilobite *Proboloides cuspidatus* Clarke,† but in other characters the head-shield is more like *D. paituna* Hartt and Rathbun,‡ while the channelled doublure and rostral shield resemble *D. falklandicus* Clarke.§ *D. brevicaudatus* Kozl.‖ from Bolivia possesses a somewhat similar rostral spine, but in other characters it is different.

Dalmanites (*Acastella ?*) *pseudoconvexus* sp. nov.

(Pl. IX, figs. 8, 9 ? .)

Head-shield transversely semicircular, slightly angulated in front, strongly convex from side to side. Genal angles provided with rather long, slender, rounded spines, projecting backwards. Glabella subquadrate, not widening anteriorly, parallel-sided, anterior end rounded; frontal lobe short, transverse, not swollen; first lateral furrows oblique; second lateral furrows short, horizontal, weaker at outer ends; basal lateral furrows strong, deep, ending with pit at inner ends; axial furrows shallow, faint, parallel. Meso-occipital

* Clarke, Mem. 9, New York State Mus., pt. 1, 1908, pp. 131–133.

† Clarke, "Foss. devon. Parana," 1913, p. 135, pl. vii, figs. 13–19.

‡ Clarke, Archiv Mus. Nac. Rio de Janeiro, vol. ix, 1890, p. 39, t. i, figs. 13, 16, 17; Lake, Quart. Journ. Geol. Soc., vol. lxii, 1906, p. 429, pl. xl, figs. 9, 10.

§ Clarke, *op. cit.*, 1913, p. 105, pl. v, figs. 1–4.

‖ Kozlowski, *op. cit.*, 1923, p. 39, pl. ii, figs. 6–8.

furrow strongest at sides, arched forward in middle ; meso-occipital ring rounded, simple, without nuchal spine or tubercle. Cheeks broadly triangular, gently convex, arched down. Eyes small, prominent, elevated, extending from behind first lateral furrow to middle of second lateral lobe of glabella, with high, vertical, strongly arched, lentiferous face bearing 22–23 vertical rows of lenses, with 8–10 lenses in middle rows. Pleuro-occipital furrow nearly straight, strong, meeting very weak, broad, shallow, marginal furrow at about 60° ; lateral border of head-shield scarcely marked off, somewhat flattened. General surface of head-shield granulated. Frontal lobe of glabella with a few indistinct small tubercles.

Dimensions (419 Kimb. Mus.) :—

Length of head-shield . .	20 mm.
Width of ,, . .	36 ,,
Length of glabella . . .	16 ,,
Width of ,, . . .	16 ,,

Remarks.—This head-shield which comes from Hoenderfontein, Clanwilliam, is almost identical (except for the genal spines) with the Bolivian *Cryphaeus convexus* Ulrich,* a species which Knod and Groth † placed in the genus or subgenus *Acaste.* It is also much like *Dalmanites Heberti* Gosselet ‡ which Barrois § and others consider identical with *Acaste spinosa* Salter. But it seems to be extending too much the meaning of *Acaste* (if we retain the name at all) to include these forms in that genus or subgenus. *A. spinosa* occurs in the Siluro-Devonian beds of Lievin, but it is typically a Silurian species. The characters of the head-shield, glabella and eyes of *A. Lombardi* Kozlowski,‖ from the Devonian of Brazil, seem to present a considerable resemblance to our new South African species, but Kozlowski does not state that the genal angles are spined. However, he states that it belongs to the austral group of species, having a head-shield much like *Dalmanites* with a pygidium possessing the characters of *Phacops.*

In the South African Museum there are some pygidia (7201 S.A. Mus.),

* Ulrich, Neues Jahrb. f. Miner. Geol., Beil. Bd. viii, 1893, p. 16, t. i, fig. 9 ; Knod, *ibid.*, Beil. Bd. xxv, 1908, p. 499, t. xxi, fig. 4.

† Groth, Bull. Soc. Geol. France, ser. 4, vol. xii, 1912, p. 607, pl. xviii, fig. 4, 4*a* ; pl. xix, fig. 1.

‡ Gosselet, Esquisse Geol. Nord, 1880, p. 66, pl. i, fig. 4.

§ Barrois, Leriche, etc., "Faune Siluro-devon. Lievin," Mém. Soc. Geol. Nord, vol. vi, pt. 2, fasc. 2, 1920, p. 120, pl. xv, figs. 6, 7 ; p. 160, pl. xvii, figs. 1, 2.

‖ Kozlowski, "Foss. dev. Parana," Ann. de Paléont., vol. viii, 1913, p. 14, pl. iii, figs. 7, 7*a*, *b*.

also from Hoenderfontein, in precisely the same condition and matrix as the above-described head-shield from this locality, and from their resemblance to that of the above-mentioned *D. Heberti* Gosselet we may refer them without much hesitation to the same species. The description is as follows: Pygidium triangular, as wide as long, sharply pointed behind, the sides converging at about 75° to meet in a short, sharp, flattened mucro. Axis wide, convex, conical, regularly tapering to blunt tip at base of mucro, with anterior half composed of 3–5 complete rings, but posterior half faintly annulated with 5–7 rings. Pleural lobes wide, gently inclined, the anterior edge with obtuse fulcrum situated at less than one-third the width, and having a strong, oblique furrow behind it; pleurae 3–4 on each side, low, straight, broad, ending inside border, and having faint, straight, median furrow; interpleural furrows weak. Border smooth, somewhat flattened, not definitely marked off. General surface of pygidium closely and coarsely granulated.

Dimensions:—

Length of pygidium with mucro .	20 mm.
Width of ,, ...	23 ,,
Width of axis	9 ,,

In a recent paper * on a Silurian type of pygidium from the Upper Ludlow of the Woolhope district, the author has suggested the subgeneric name *Acastella* for the group of species comprising "*Acaste*" *spinosa* and *D. Heberti*, and it seems probable that our new Bokkeveld species from Hoenderfontein belongs to it.

Dalmanites (*Cryphaeus*) *caffer* Salter (emend.).

(Pl. IX, figs. 10, 11; Pl. XI, fig. 4.)

1856. *Phacops* (*Cryphaeus*) *caffer* Salter (pars), Trans. Geol. Soc., ser. 2, vol. vii, p. 219, pl. xxv, figs. 11, 12, 12*a* (11290 Brit. Mus.), *non* figs. 10, 13.

1856. *Phacops africanus* Salter (pars), *ibid.*, pl. xxv, fig. 4 (11286 Brit. Mus.), *non. cet.*

1904. *Phacops* (*Cryphaeus*) *caffer* Lake, Ann. S. Afr. Mus., vol. iv, pt. 4, p. 210, pl. xxv, figs. 3, 4 (18, 34 S.A. Mus.).

? 1923. *Cryphaeus australis* Kozlowski (pars), "Faune Devon. Bolivie," Ann. de Paléont., vol. xii, p. 41, pl. iii, figs. 15–17 (*non cet.*).

* Reed, Geol. Mag., vol. lxii, No. 728, 1925, p. 73, pl. ii, figs. 4, 4*a*.

The first figured specimen (Salter, *op. cit.*, fig. 10) of this species is a head-shield described as " a young individual," but unfortunately its characters do not at all agree with Salter's definition of the species, which, on the other hand, describes the characters found in the second figured specimen (*op. cit.*, fig. 11). It is therefore the latter which must be regarded as the type of the species, and the " young individual " has to be placed either in Lake's *Phacops* (*Calmonia*) *ocellus* (*q.v.*), or in the author's new species, *Ph.* (*Calm.*) *Lakei*.

The specimen (11290) of the head-shield from Leo Hoek figured by Salter (*op. cit.*, fig. 11), which is chosen here as the type of *Ph. caffer*, has a small median frontal apiculus or rostral point and subangular genal angles. Though the base of the glabella and occipital ring are missing, we can see that the frontal lobe is transverse and inflated, and has its lateral angles slightly overhanging ; the lateral furrows, so far as they are preserved, are correctly shown in Salter's figure, and the anterior branches of the facial sutures meet at an obtuse angle in front of the glabella. The general surface of the glabella is covered with small, scattered, rather distant tubercles or coarse granulations, but on the frontal lobe they are more numerous and rather larger, and seem to be more or less fused into sinuous lines. The border is gently rounded, but only finely granulated, and the cheeks are coarsely pitted, while in the shallow, wide, marginal furrow are short, weak, radial markings, such as Clarke* shows in the figure of an unnamed species of *Dalmanites* from Bolivia.

Dimensions (11290 Brit. Mus.): Length of head-shield, 30–35 mm. ; Width of head-shield, *c.* 70 mm.

There is a good head-shield (838 S.A. Mus.) from an unknown locality in the South African Museum, and a large number of specimens of this type of head-shield in the collection of the University of Cape Town (142, 169, 175, 179), from the Touws River Road, in a good state of preservation, and the following emended description of the specific characters of the head-shield may be given : Head-shield semicircular to semi-oval, moderately convex, cheeks not much bent down ; genal angles bluntly pointed, not spinose, the lateral and posterior margins being inclined at an angle of about 75°. Glabella subquadrate to subclavate, the frontal lobe very large and inflated, equal to or more than half the length of the glabella, with median pit at base ; posterior half of glabella depressed, somewhat flattened ; first lateral furrows strong, straight, oblique ; second and third lateral furrows

* Clarke, *op cit.*, 1913, pl. v, figs. 16, 17.

horizontal, represented by long transversely oval pits, usually connected by weak grooves with axial furrows; second and third lateral lobes subequal, small, partly confluent at outer ends. Meso-occipital ring simple, rounded; meso-occipital furrow strong, gently arched forward. Cheeks rather swollen, with well-defined lateral border, marked off by distinct broad marginal groove; pleuro-occipital ring rounded; pleuro-occipital groove strong, deep, straight, uniting with marginal groove at angle of about 75°. Eyes rather large, elevated, reaching from first lateral furrow to middle of second lateral lobe, situated close to glabella; eye lobe convex, with sub-marginal groove and swollen edge. Pre-glabellar border of head-shield very narrow, but produced in front into very short, triangular, spatulate, flattened rostrum. Surface of head-shield covered with coarse granulations of rather unequal size. Doublure rounded, convex around anterior cephalic edges, but slightly bent up and concave in middle.

For the association of the head-shield which Lake described as *Ph. caffer* with the pygidium and thorax which he figured under the same name, he relied on associated but disconnected portions. But though isolated head-shields and pygidia are more abundant there is the impression of a complete individual (H 173) in the Stellenbosch Museum from Buffelskraal, and of another from the Cockscomb Mountains in the Bloemfontein Museum, which remove any doubt from our minds of the accuracy of Lake's view. Lake's pygidium of *Ph. caffer* agrees, however, in all essentials with the one from Hottentot's Kloof which Salter figured (11286 Brit. Mus.) (*op. cit.*, pl. xxv, fig. 4) as belonging to *Ph. africanus*, but it is in a crushed and somewhat distorted condition, so that the marginal spines are unduly elongated, and Salter's figure is largely a restoration. Clarke * considered that Salter's specimen was " a very exact expression of *Cryphaeus australis* Clarke," and Salter's figure would lead us to this conclusion if we had not had the opportunity of seeing the specimen itself. Lake's specimen of the pygidium of *Ph. caffer* is in a much better state of preservation, and from an examination of a large number of similar pygidia from the Bokkeveld Beds we are able to define its characters as distinct from those of *Cryphaeus australis*. The differences consist in the shorter, broader, and more incurved subfalcate shape of the marginal spines of the pygidium, and especially in the absence of a terminal median point, the margin between the last pair of spines being usually truncated and projecting merely as a short, broad,

* Clarke, *op. cit.*, 1913, pp. 113, 108*a*–114.

rounded lappet, just as in certain Bolivian specimens attributed to *Cryphaeus australis* by Kozlowski (*op. cit.*, pl. iii, figs. 15–17).

From two excellent pygidia with portions of the thorax attached (E 414, E 483, Stell. Mus.), from Osplaats, Hex River Valley, and the complete individual (H 173), also in the Stellenbosch Museum, from Buffelskraal, De Doorns, as well as from the fine specimen in the Bloemfontein Museum from the Cockscomb Mountains, and from specimens in the Sedgwick Museum, Cambridge, and others collected by me near De Doorns, we are able to give a fuller description of the characters of the thorax and pygidium than was previously possible :—

Thorax somewhat flattened. Axis convex, broad, fully one-third the width of thorax at front end, tapering rather rapidly ; axial rings with slight lateral swellings. Pleurae horizontal out to fulcrum, which is situated at less than half their length, then bent down and slightly curved forwards ; pleural furrow deep, strongest at fulcrum, dying out before reaching tip of pleurae, curving somewhat forwards beyond fulcrum ; pleurae ending in free, short, slightly-falcate points. Pygidium broadly semi-elliptical to subparabolic, very gently convex from side to side, angulated at tip. Axis wide, conical, tapering rather rapidly for first 5 rings and then more slowly to blunt tip at some distance inside margin, annulated for whole length with 9–12 rings, of which the anterior ones have distinct lateral swellings. Pleural lobes composed of 5 pairs of pleurae, ending in short, broad, subfalcate, free marginal spines, directed backwards and of subequal size, usually slightly swollen and more or less curved inwards, the last pair projecting behind the posterior margin of the pygidium and embracing a short, transversely, subquadrate, median postaxial piece (caudal lappet) arched up in the middle, and with sharply or broadly rounded tip ; each pleura traversed by deep, rounded, broad, submedian furrow, expanding outwards and ending suddenly before base of spine ; interpleural furrows fine, narrow, not deeply impressed. Behind the fifth pleura there is a narrow, weak, curved, rounded ridge, running straight back on each side and passing into the lateral margins of the postaxial piece, representing a sixth pair of pleurae. Surface of axis coarsely granulated ; pleural lobes with smaller granulations.

(In some specimens (11286 Brit. Mus.) there is a small, median, marginal swelling on the postaxial piece of the pygidium, but in most cases it is not visible.)

Dimensions :—

	(Bloemfontein.)	(H 173 Stell. Mus.)	(142 Univ. Cape.)
Length of head-shield .	23 mm.	15 mm.	26·5 mm.
Width of ,, .	38 ,,	30 ,,	45·0 ,,
Length of glabella .	21 ,,	*c.* 14 ,,	20·5 ,,
Width of ,, at base	14 ,,	9 ,,	14·0 ,,
,, ,, ,, at front	20 ,,	15 ,,	23·0 ,,
Length of eye . .	9 ,,	*c.* 5 ,,	. .
,, of thorax . .	35 ,,	20 ,,	. .
,, of pygidium .	19 ,,	13 ,,	. .
Width of ,, .	25 ,,	*c.* 19 ,,	. .

Remarks.—As above mentioned, the pygidium of *D. caffer* is almost identical with certain Bolivian specimens attributed to *Cr. australis*, the truncate shape of the median unpaired lappet being characteristic in the Bokkeveld species. The thorax seems to possess no definite distinctive features. The head-shield, however, has a more inflated frontal lobe, larger eyes, and a frontal rostrum such as we find in *Dalmanites longicaudatus* Murch. of the British Upper Silurian, as Clarke mentions in connection with *Proboloides*, which is the austral equivalent of the boreal *Probolium*. The Canadian species from Gaspé, *D. Griffoni* Clarke,* and *D. Gaveyi* Clarke,† which occur there in the early Devonian fauna, are closely similar. But *Cr. australis* has no such marginal projection, and it is not always preserved in our Bokkeveld specimens. Kozlowski ‡ believes that *Cr. giganteus* Ulrich § which was founded on a pygidium, is identical with *Cr. australis*.

Of European species we may especially mention *Cr. rotundifrons* Emmr. ‖ from the Upper Coblenzian, for it has a small rostrum to the head-shield and rather broad incurved marginal spines on the pygidium, as well as a glabella with characters much like *Cr. caffer*.

The name *Cryphaeus* Green, is employed here in place of *Pleuracanthus*, Corda, in spite of its preoccupation as pointed out by the

* Clarke, Mem. 9, New York State Mus., pt. 1, 1908, p. 103, pl. vii, fig. 4; pl. ix, fig. 4, text-fig. p. 133.

† *Ibid.*, p. 128, pl. viii, figs. 8, 9, text-fig. p. 133.

‡ Kozlowski, *op. cit.*, 1923, p. 41.

§ Ulrich, *op. cit.*, 1893, p. 14, t. iii, fig. 6 (? 7, 8).

‖ Richter, Jahrb. preuss. geol. Landesanst., Bd. xxxvii, 1916, Heft i, p. 250, t. xxvi, figs. 7–14.

author in 1905.* For Clarke † and all other palaeontologists still use Green's name, as they are of the opinion that no confusion can arise in its well-established application to this type of trilobite.

Dalmanites (*Cryphaeus*) *caffer*, Salter, var. nov. *albana*.

(Pl. XI, fig. 1.)

There is a nearly perfect, but slightly distorted, impression of a large head-shield of a species of *Phacops* from Winterhoek, in the Albany Museum (69), which deserves description. The head-shield is transversely semicircular, more than twice as wide as long; the anterior margin is very obtusely angulated in the middle. The glabella is broadly subquadrate, but widens slightly anteriorly; its sides are straight, and its front end is rounded; its whole surface is rather inflated. The frontal lobe is somewhat more swollen and is marked off behind by long, straight, oblique lateral furrows, which are strongly impressed except near their commencement; the second and third lateral furrows are straight, nearly horizontal, and deepest internally, being very faint and weak near their outer ends. The meso-occipital furrow is straight and deepest at the sides, and the meso-occipital ring is a simple rounded band without any nuchal spine. The cheeks are rather coarsely pitted, and the eyes are rather large and prominent, reaching from the first to somewhat behind the second lateral furrows; the eye lobe is angulated. The genal angles are broken off, but the pleuro-occipital furrow which is straight meets the marginal furrow at about 45°, so that they were probably bluntly pointed. The whole surface of the glabella is covered with small round tubercles, and there is a median pit at the base of the frontal lobe.

Dimensions (69 Alb. Mus.) :—

Length of head-shield . .	24 mm.
Width of ,, . .	58 ,,
,, ,, glabella at base .	20 ,,
,, ,, ,, at front .	26 ,,

Remarks.—This head-shield differs from *D. caffer* as above defined by the more subquadrate shape of the glabella and absence of a frontal projection. In these respects it resembles the Bolivian trilobite figured and described by Kozlowski ‡ as *Cryphaeus australis*

* Reed, Geol. Mag., Dec. v, vol. ii, 1905, p. 173.

† Clarke, "Foss. devon. Parana," 1913, p. 108.

‡ Kozlowski, *op. cit.*, 1923, p. 41, pl. iii, figs. 1, 9–11.

Clarke, var. *rotundata*, which is certainly distinct from the typical *Cr. australis* which has a subclavate glabella, and this Bolivian variety seems to deserve specific rank. The tuberculation in our specimen from Winterhoek is coarser than in *Ph. caffer*, and is more like that of Kozlowski's other variety, *Cr. australis* var. *tuberculata*.*

Dalmanites (*Cryphaeus*) *caffer*, Salter, var.

There is one specimen (161 Cape Univ.) from the Touws River Road in the collection of the Cape University which consists of a pygidium, with 5 thoracic rings attached, showing some minor characters which seem to mark it off as a variety. The axis decreases more rapidly in width in the anterior half, but in the posterior half is nearly cylindrical. The median lappet projects more than in the typical *D. caffer*, forming a short, bluntly-pointed, sublanceolate process, instead of being abruptly truncate, and on the edge at its tip there seem to be 1 (or 2) small spinose, upturned tubercles. Salter showed a small, median swelling in the same place in his figure (*op. cit.*, pl. xxv, fig. 4) of the pygidium (11286 Brit. Mus.), which he attributed to *Ph. africanus*, but which we now refer to *Ph. caffer*. The five pairs of lateral lappets in our specimen have their surface angulated along their length instead of simply rounded, and this does not seem due to crushing. The whole surface of the pygidium is coarsely granulated, and in all other respects but the above-mentioned seems indistinguishable from the ordinary *D. caffer*. Some figures of pygidia of *Cr. australis* given by Clarke and Kozlowski appear identical with our variety (except in the terminal tubercles), and we may specially mention that of the variety *tuberculata* Kozl.†

Dalmanites (*Cryphaeus*) cf. *australis* Clarke.

(Pl. XI, fig. 9.)

It is possible that this species is represented in the Bokkeveld Beds, for there is one specimen of a head-shield (3850 S.A. Mus.) from Hottentot's Kloof, Ceres, which resembles some of those figured by Clarke ‡ more closely than it does those ascribed in this memoir by the present author to *D.* (*Cr.*) *caffer*. The eyes are smaller and placed further forward than in the latter, the genal angles are more acutely

* Kozlowski, *op. cit.*, 1923, p. 43, pl. iii, figs. 20, 21.

† *Ibid.*, p. 43, pl. iii, fig. 21.

‡ Clarke, *op. cit.*, 1913, pl. iii, figs. 10, 13, 14 ; pl. iv, fig. 3.

pointed and somewhat prolonged backwards, and the frontal lobe of the glabella is less inflated. All Kozlowski's figures of head-shields which he ascribes to *Cr. australis* have too broad and subquadrate a glabella to be regarded as identical with this species.

Dalmanites (*Cryphaeus*) cf. *Pentlandi*, Salter.

(Pl. XI, fig. 10.)

There is one imperfect pygidium (447 Pret. Mus.) in the Pretoria Museum from Tunnel Siding near Triangle, which is referable to some species of *Cryphaeus*, and deserves some description on account of its unusual ornamentation. The right pleural lobe is hidden beneath tough matrix, and the marginal spines, with the exception of the fifth one on the left pleural lobe, are broken off. The pygidium has the shape and general characters of *Cr. caffer*. The axis is conical and is annulated to the blunt tip with 11 rings. Behind it is a small, smooth, postaxial piece, apparently truncated and not pointed behind, and embraced laterally by the nearly obsolete, short, faintly-marked, curved, sixth pleurae, which have no free ends. The pleural lobes are flattened and composed of 5 elevated pleurae, each divided in its outer two-thirds by a median or submedian furrow into an anterior and posterior band of equal or subequal width. The pleurae die out before reaching the edge, leaving an ill-defined border; the marginal spines are broad, curved, unfurrowed, and flattened. Along the inner part of the anterior and posterior band of each pleura is a single row of 5–7 coarse, rounded tubercles, and on each ring of the axis there are 6–8 similar equidistant tubercles, arranged in roughly-longitudinal lines for the whole length of the axis.

The only species described which has a somewhat similar tuberculation and rudimentary sixth pair of pleurae on the pygidium is the imperfectly known *Cr. Pentlandi* Salter,* from Bolivia.

In the South African Museum there is the impression of the thorax and pygidium of a large example of this form from De Doorns (2463 S.A. Mus.), showing the coarse tuberculation very clearly. The axis of the thorax is broad and subcylindrical, decreasing very slowly in width posteriorly, and the rings are very coarsely tuberculated and have a few transverse wrinkles, but the tubercles are irregularly distributed, whereas on the attached pygidium they are in a regular single row, as in the other specimen (447).

* Salter, Quart. Journ. Geol. Soc., vol. xvii, 1861, p. 65, pl. iv, fig. 9; Kozlowski, *op. cit.*, 1923, p. 46, pl. ii, fig. 18.

The thoracic pleurae are likewise coarsely and rather irregularly tuberculated, but the tubercles tend to be arranged more definitely in a row or rows along the anterior and posterior pleural bands, and there is a curious transverse wrinkling of the pleurae as of the axis, recalling that seen in some species of *Dionide*; the pleural furrow is strong, deep, slightly diagonal, and submedian; the fulcrum is obtuse and situated at one-third to one-fourth the length of the pleurae. In the pygidium the sixth rudimentary pair of pleurae are well seen, curving in, and forming the sides of the postaxial piece behind the end of the axis. The postaxial piece is bluntly pointed and slightly swollen at the tip.

Dimensions (2463 S.A. Mus.):—

Length of thorax . .	46 mm.
Width of thoracic axis .	18 ,,
Length of pygidium . .	25 ,,

Dalmanites (*Cryphaeus ?*) cf. *rostratus*, Kozlowski.

(Pl. VIII, fig. 2.)

1923. *Cryphaeus rostratus* Kozlowski, "Faune Devon. Bolivie," Ann. de Paléont., vol. xii, p. 44, pl. v, figs. 1–10.

The peculiar upturned rostral doublure which Kozlowski describes and figures in his new species *Cr. rostratus* from the Devonian of Bolivia, is excellently exhibited in a specimen collected by myself at the road-side cutting north of De Doorns. The anterior view of the head is alone displayed, the upper surface being buried in matrix, but part of the frontal lobe of the glabella with the encircling facial sutures, the lateral margin of the right cheek, as well as the triangular, gently-concave rostrum which bends up suddenly almost at right angles to the general plane of the head-shield, are clearly seen, and the granular ornamentation over the whole surface also precisely corresponds with the Bolivian examples. The height of the rostrum is about 8·5 mm., and its subacute tip stands up prominently above the level of the frontal lobe of the glabella, as in Kozlowski's figures 7 and 5*a*.

As he remarks, this species differs considerably from all other species comprised in the subgenus *Cryphaeus*, not only in the upturned rostral process, but also in the prominence of the eye lobes which stand up as spines, and in the shape and lobation of the glabella, and I believe it is more allied to his *Proboloides Cottreaui*,* which has a

* Kozlowski, *op. cit.*, 1923, p. 53, pl. ii, figs. 10, 10*a*.

somewhat similar upturned rostral doublure. The thorax and pygidium of this species also possess certain peculiar features, but no fragments of these parts have been detected by me in the South African collections.

Dalmanites (*Cryphaeus ?*) *ceres*, Schwarz.

? 1903. *Phacops arbuteus*, Lake (pars), Ann. S. Afr. Mus., vol. iv, pt. 4, p. 203, pl. xxiv, fig. 3 (61 S.A. Mus.) (*non* figs. 2, 4).

1906. *Phacops* (*Cryphaeus*) *ceres*, Schwarz, Rec. Albany Mus., vol. i, pt. 6, p. 394, pl. x, figs. 1, 1*a* (67 Alb. Mus.).

This species was founded on two head-shields in the Albany Museum (locality unknown), and its author considered that it was very close to *Ph.* (*Cryph.*) *giganteus* Ulrich, from Bolivia, which Kozlowski * believes is identical with *Ph.* (*Cryph.*) *australis* Clarke (*q.v.*). With Schwarz's view I can only agree, if we admit that Kozlowski is right in referring all the Bolivian specimens which he figured to Clarke's species.

The figure which Schwarz gave is poor and somewhat misleading, for the glabella is pentagonal and widens a little anteriorly, though it is drawn as parallel-sided ; there is also a pair of parallel longitudinal rows of tubercles on the frontal lobe, as in *Ph. callitris* Schw., with some irregularly disposed tubercles on each side. There is no nuchal spine, the meso-occipital ring being smooth and simple. The genal angles are broken ; the pleuro-occipital furrow is straight. In the paratype (27 Alb. Mus.) the blunt rostral angulation in the middle of the anterior margin of the head-shield is preserved, but it is broken off in the figured specimen. The eyes possess 24–25 vertical rows of lenses, with 7–8 lenses in the middle rows.

It seems to the present author that the figured head-shield is closely similar to the imperfect one from Gamka Poort, which Lake ascribed to *Ph. arbuteus* (*op. cit.*, *supra*) (61 S.A. Mus.), for this has a much less coarse tuberculation of the surface than the type of Lake's species (Lake, *op. cit.*, pl. xxiv, fig. 2) ; the distribution of the tubercles is quite different, and there are other points of distinction ; the glabella is subpentagonal in shape, though owing to distortion its true outline is difficult to determine, and it is longer than wide ; there are 3 pairs of lateral furrows on it, but they are mostly weaker near the axial furrows, and extend more than one-third across, so as to leave only a narrow median band down the centre ; the first lateral furrow starts nearly from the anterior lateral angles of the glabella, making

* Kozlowski, *op. cit.*, 1923, p. 41.

the frontal lobe short and transverse; there is a large median pit at the base of the frontal lobe which is covered with rather coarse, widely separated tubercles, but the rest of the glabella has smaller, more closely set, and low tubercles. The axial furrows are subparallel posteriorly, but diverge somewhat anteriorly. The fixed cheeks are swollen and smooth. The meso-occipital ring is rounded and bears no clear evidence of a nuchal spine.

Dimensions (61 S.A. Mus.) :—

Length of glabella . . .	20·0 mm.
Width at front . . .	18·5 ,,
,, at base . . .	14·0 ,,

In the Albany Museum there is a specimen of a head-shield (71 Alb. Mus.) from the Winterhoek Range, labelled *Ph. pupillus* Lake, but it does not seem to belong to that species, for the right genal angle, which is preserved, is produced back into a long spine at least one-third the length of the head-shield, much as in *D.* (*Hausmannia*) *accola* Clarke,* from the Devonian of Brazil; the pleuro-occipital furrow meets the marginal furrow at the base of the spine at an angle of about 75°; there is a double row of median tubercles on the frontal lobe as in the type of *Ph. ceres* and *Ph. callitris*; the anterior margin of the head is bluntly angulated, and only the third lateral furrows reach the axial furrows, though the two anterior pairs are well marked. Perhaps it is referable to *D. ceres*.

Phacops (*Calmonia*) *callitris* Schwarz.

1906. *Phacops* (*Cryphaeus*) *callitris*, Schwarz, Rec. Albany Mus., vol. i, pt. 6, p. 393, pl. x, figs. 2, 2*a*, 2*b* (29 Alb. Mus.).

Schwarz founded this species on two head-shields from the Cedarbergen (29 Alb. Mus., and 34 Alb. Mus.). The marginal supragenal spines are clearly indicated in his figure (*op. cit.*, pl. x, fig. 2), but the eyes are represented as too small and placed too far forward, and the glabella is more quadrate. The frontal lobe has two parallel longitudinal rows of 4–6 small, low tubercles on its surface with a shallow groove between them, and similar tubercles are scattered irregularly on each side of them. The course of the facial suture is not clearly shown in Schwarz's figures; the posterior branch at first runs out from the eye in a nearly straight line parallel to the posterior margin of the head-shield, but then bends back very

* Clarke, *op. cit.*, 1913, p. 101, pl. iv, figs. 9–18.

suddenly close to the lateral edge, which it cuts just in front of the supra-genal spine; the posterior margin and genal angle up to the spine form a continuous curve, the spine being directed outwards. This species may certainly be referred to the subgenus *Calmonia*, and appears to be allied to *C. signifer* Clarke.* There is a small head-shield of this species (I 4955, Brit. Mus.) from the Cedarberg in the British Museum.

It may be that Salter's *Ph. caffer* "young" (*op. cit.*, pl. xxv, fig. 10) belongs to this species rather than to *Ph. Lakei* sp. nov., under which it is here described (see p. 154).

Clarke † established the genus *Calmonia* for the group of species typified by his new Brazilian species *C. signifer*, and he regarded it as falling within the present author's group, *Metacryphaeus*,† which was undoubtedly a composite assemblage of somewhat heterogeneous forms, and the name can only be used in a broad sense to include several subgenera or genera. Thus Clarke puts in it *Pennaia* and *Proboloides* as well as *Calmonia*, and is inclined to ascribe to it also the blind genus *Typhloniscus*. Kozlowski ‡ regards *Calmonia*, *Pennaia*, and *Proboloides* as subgenera of *Acaste*, and even includes in this genus *Phacopina*, *Typhloniscus*, and *Anchiopella*. Clarke instituted a main division, which he termed *Mesembria*, to include nearly all the Phacopidae of the austral fauna, and in this division he recognised two subdivisions, *Metacryphaeus* and *Anchiopella*. *Dalmanites* and *Cryphaeus* of the latter were kept apart by Clarke as separate genera, but Kozlowski § puts *Cryphaeus* as a subgenus of *Dalmanites*, and Clarke ‖ himself states that "it has no higher generic value than other subdivisions of *Dalmanites*."

Phacops (*Calmonia*) *impressus*, Lake.

1904. *Phacops impressus*, Lake, Ann. S. Afr. Mus., vol. iv, pt. 4, p. 209, pl. xxv, figs. 1 (43 S.A. Mus.), 2 (50 S.A. Mus.).

Lake (*op. cit.*) thought that one of the specimens of a nearly complete individual, figured by Salter (*op. cit.*, pl. xxv, fig. 13, 11291 Brit. Mus.) as belonging to *Ph. caffer*, was referable to *Ph. impressus*, but more probably this is a *Pennaia*; he also regarded it as probable that

* Clarke, "Foss. dev. Parana," 1913, p. 121, pl. vi, figs. 1–12; pl. vii, figs. 20, 21.

† Clarke, *op. cit.*, 1913, pp. 121, 152, 153.

‡ Reed, Geol. Mag., Dec. v, vol. iv, 1907, p. 168.

§ Kozlowski, *op. cit.*, 1923, pp. 30, 32, 41.

‖ Clarke, *op. cit.*, 1913, p. 156.

it was the form referred to by Salter as *Phacops* sp. 3. Lake's figured specimens are from Gamka Poort, and are in the South African Museum (43 and 50 S.A. Mus.); the first figured one (43) consists of a nearly-complete much compressed, and partly-enrolled specimen, of which the head is in a very poor state of preservation, but the second (50) is a pygidium, and Lake clearly bases his species mainly on its characters. It is certainly a true and typical member of *Calmonia*, and is more closely allied to *C. subseciva* Clarke * of the Brazilian Devonian rather than to *C. signifer* Clarke, or its variety *micrischia*.† The pygidium and thorax of another specimen in the same Museum (65 S.A. Mus.) seem practically indistinguishable from *C. subseciva*. One of the characteristic features of the pygidium in both these species is that the pleurae are flattened, of regular width, have a weak median instead of a diagonal furrow (sometimes only present in the outer half), and do not reach the margin. The margin of the pygidium in Lake's specimen (43 S.A. Mus.) shows traces of 3–4 short spines, but Lake says that the number of these is uncertain. The eyes of *Ph. impressus* have 26–30 vertical rows of lenses, and the middle rows contain 8–10 lenses; the eyes themselves are large, and reach from the first to the third lateral furrows of the glabella. There is a pygidium (11299 Brit. Mus.) in the British Museum from the Gydo Pass, showing the same characters as Lake's types from Gamka Poort, and two head-shields (52061 Brit. Mus.), also from the Gydo Pass, showing the large eyes, may probably be referred to it. In a complete but crushed specimen (2556 Alb. Mus.) in the Albany Museum from the type locality, Gamka Poort, the genal angle possesses a short lateral spike, as in *C. signifer* Clarke; the large eyes show about 26 rows of lenses, with 8–10 in the middle rows; the margin of the pygidium seems to be entire and devoid of spines.

Phacops (*Calmonia*) *impressus* Lake, var. nov. *vicina*.

(Pl. XI, fig. 8.)

Head-shield transversely semicircular, with front end projecting and angulated obtusely, very gently convex; genal angles produced slightly backwards, bluntly pointed; rostral shield triangular, broad, projecting in front. Glabella broad, subtrapezoidal, widening slightly anteriorly, not inflated; first lateral furrows represented by shallow, isolated pits, very faint or obsolete; second lateral furrows represented

* Clarke, *op. cit.*, 1913, p. 126, pl. vii, figs. 1–10.

† *Ibid.*, p. 124, pl. vi, figs. 13–16.

by short, isolated, deep, transverse, oval pits, not connected with axial furrows; basal furrows stronger and deeper, with outer ends curved forwards and uniting with axial furrows. Meso-occipital furrow strong at sides. Cheeks triangular, with rounded, well-defined, lateral border and narrow doublure; eyes large, close to glabella at anterior end, extending from first lateral furrows to behind basal furrows.

Thorax of 10 or 11 segments; axis wide, cylindrical, each axial ring having distinct lateral swellings. Pleurae broad, somewhat expanded at ends, with rounded fulcrum at about one-third their length, and extra fulcral portion curving back and then forwards to end in blunt truncated tips; diagonal pleural furrow strong, sigmoidal.

Pygidium broadly semicircular, gently convex; margin entire, except for 1 or 2 small, very short, triangular denticles corresponding to first (?) and second pleurae. Axis subconical, annulated to blunt tip with 8–10 rings; lateral lobes gently convex, composed of 5–6 flattened pleurae, corresponding to the anterior axial rings, and ending a little distance inside edge of pygidium; each pleura with fine median furrow for its whole length; interpleural furrows strong, deep, ending inside undefined, smooth, marginal band, without marginal furrow. No definite border. Surface of trilobite covered with small tubercles or coarse granulations.

Dimensions (418 Kimb. Mus.) :—

Length of head-shield . .	*c.* 14 mm.
Width ,, ,, . .	*c.* 27 ,,
Length of thorax . . .	23 ,,
Width of axis of thorax . .	*c.* 10 ,,
Length of pygidium . .	10 ,,
Width ,, ,, . .	*c.* 19 ,,

Remarks.—The specimen from which the above description has been drawn up is in the M'Gregor Museum, Kimberley, and was collected at Gamka Poort. It consists of an entire individual, with the exception of the anterior part and left side of the glabella and head-shield, the occipital ring, and the first 5–6 thoracic pleurae on the left side which have been broken off. Apart from the curious curvature of the basal furrows, causing the conjoint first and second lateral lobes of the glabella to have a rounded external outline and the larger eyes, there seem to be no distinctive characters by which we can separate it from *Ph. impressus*, which, as above remarked, is closely allied to the Brazilian *Calmonia subseciva* Clarke.*

* Clarke, *op. cit.*, 1913, p. 126, pl. vii, figs. 2–10.

Of European allied species we may mention "*Acaste*" *Henni* Richt.* and "*Ac.*" *Schmidti* Richt.† of the Upper and Lower Coblenzian.

Phacops (*Calmonia*) *ocellus*, Lake.

1856. *Phacops africanus* Salter (pars), Trans. Geol. Soc., ser. 2, vol. vii, p. 218, pl. xxv, fig. 2 (11284 Brit. Mus.); fig. 6 (14956 Brit. Mus.); fig. 9 (14957 Brit. Mus.), *non cet.*

1904. *Phacops ocellus* Lake, Ann. S. Afr. Mus., vol. iv, pt. 4, No. 9, p. 207, pl. xxiv, fig. 9 (14956 Brit. Mus.); figs. 10*a*, *b* (14957 Brit. Mus.).

The characters of this species were clearly described by Lake, but he founded it on the head-shield from the Cedarberg (14956 Brit. Mus.) which Salter also figured (*op. cit.*, fig. 6). Schwarz ‡ does not think that Lake was justified in associating with it the thorax and pygidium (14957 Brit. Mus.) from the same locality. The head is almost indistinguishable from Schwarz's *Ph. callitris*,§ but I cannot see any trace of supra-genal spines in Salter's specimen, and the genal angles are certainly rounded and not produced back into genal spines as Salter dotted in. Clarke || figures specimens from the Falkland Isles as *Ph.* (*Calm.*) *ocellus* Lake, but his head-shields are rounded in front, the glabella is not angulated as in Lake's type, and is also broader, more rounded, and subquadrate in shape; the pygidium, as Clarke remarks, bears 6 pairs of marginal spines instead of 4 (or possibly 5), as Lake's type (14957 Brit. Mus.) shows, and altogether a different species seems to be represented.

The thorax and attached pygidium (11284 Brit. Mus.) from the Gydo Pass which Salter (*op. cit.*) gave as his second example and figure of *Ph. africanus*, was not referred to any species by Lake, but it seems undoubtedly to belong to some species of *Calmonia*, and though the marginal spines on the pygidium which Salter figured are no longer visible, yet we cannot fail to note its resemblance to Lake's *Ph. ocellus*, and a more precise description than Salter furnished is desirable. There are 8 segments of the thorax preserved. The axis is broad and convex, subcylindrical, and one-third the width of

* Richter, Jahrb. preuss. geol. Landesanst., Bd. xxxvii, 1916, Heft i, p. 252, t. xxv, figs. 13–16; t. xxvii, figs. 1–3.

† *Ibid.*, p. 252, t. xxvii, figs. 4–6.

‡ Schwarz, Rec. Alb. Mus., vol. i, pt. 6, 1906, p. 397.

§ *Ibid.*, p. 393, pl. x, figs. 2, 2*a*, 2*b*.

|| Clarke, *op. cit.*, 1913, p. 129, pl. v, figs. 10–15.

the thorax, with decided lateral swellings on each ring. The pleural lobes are strongly arched down; the pleurae have the fulcrum very close to the axis, being only at about one-fifth (or less) their length; the diagonal pleural furrow is strong, and the tip of the pleura is bluntly truncate. The pygidium is semi-oval, being rather longer than wide, and the axis, which is conical and tapers rather rapidly, is annulated nearly to its tip with 7 rings and has a small terminal piece; the pleural lobes consist of 5 pairs of well-marked, flattened pleurae, and a faint, small, sixth pair; the pleural furrow on each is median not diagonal, and strongest near the border; the pleurae and furrows do not reach the margin, and the narrow convex doublure is seen as a concave impression round the margin. There are no marginal spines now visible in the specimen, the edge being simple and entire, as in *Calmonia subseciva* Clarke * (though Salter's figure shows 4 pairs), but they may have been destroyed in course of time since the specimen was drawn, and their presence would make it resemble *C. signifer* Clarke,† from Ponta Grossa, especially the variety *micrischia* Clarke; ‡ indeed this Brazilian species seems in every respect indistinguishable in the characters of the thorax and pygidium.

Phacops (*Calmonia*) *Lakei* sp. nov.

(Pl. IX, figs. 4, 5.)

? 1856. *Phacops caffer* Salter (pars), Trans. Geol. Soc., ser. 2, vol. vii, pl. xxv, fig. 10 (11289 Brit. Mus.), *non cet.*

Head-shield transversely semicircular; genal angles rounded or bluntly pointed, subrectangular; border broad, rounded, convex, definitely marked off by strong marginal furrow, much narrowed in front of glabella (where it is provided with 2–3 obtuse elevated tubercles on each side of middle line ?). Glabella very broad, rounded, trapezoidal, widening anteriorly, sides very slightly arched outwards; 3 pairs of well-marked lateral furrows; anterior pair very far forward, straight, or slightly undulating, long, oblique, arising close behind lateral angles of frontal lobe; second pair represented by shorter, isolated, horizontal, or slightly wavy furrows, not reaching axial furrows; basal furrows longer, deep, nearly horizontal, or concave forwards, reaching axial furrows and nearly uniting across middle; frontal lobe not independently swollen, transverse, short, about one-

* Clarke, *op. cit.*, 1913, p. 126, pl. vii, figs. 2–10.

† *Ibid.*, p. 121, pl. vi, figs. 1–12; pl. vii, figs. 20, 21.

‡ *Ibid.*, p. 124, pl. vi, figs. 13–16.

third length of glabella; basal lobes narrow, somewhat swollen; meso-occipital ring rounded, convex, simple, widest in middle; meso-occipital furrow strong, arched forward, of uniform depth. Cheeks forming spherical triangles, not swollen; pleuro-occipital furrow strong, horizontal, meeting marginal furrow at about 75°; pleuro-occipital ring widening laterally. Eyes large, reaching from first lateral furrow to middle of second lateral lobe, semicircular, situated close to glabella, with swollen edge to eye lobe. Facial suture with short anterior branch and strongly arched posterior branch cutting lateral margin just in front of small supra-genal spine. Surface of head-shield finely and closely tuberculated or coarsely granulated. Thorax with slowly-tapering, broad, convex axis, the rings without distinct lateral swellings. Pleurae with well-marked fulcrum at about one-third their length, outside which each pleura is bent down and curves gently back and then slightly forwards to end in a free, short, subcentral, subfalcate point; pleural furrow strong, diagonal, not reaching tip. Pygidium semicircular, gently convex; margin entire. Axis convex, conical, tapering rather rapidly to blunt tip not reaching margin, annulated with 7–8 complete rings for whole length. Pleural lobes gently arching down on each side, composed of 5–6 simple flattened pleurae gently curved back, each with faint, median, pleural furrow. Surface of thorax and pygidium finely tuberculated, the tubercles on the pygidial lateral lobes arranged in a line along the length of the pleurae with some regularity.

Dimensions (232 Cape Univ.) :—

Length of head-shield . . .	16·5 mm.
Width of ,, . . .	34·5 ,,
Length of glabella . . .	13·0 ,,
Width of ,, at front . .	15·5 ,,
,, ,, ,, at base . .	11·5 ,,
Length of eye	6·0 ,,

Remarks.—This species seems to agree better with *Ph. convexus* Ulrich * than with *Ph. ocellus* Clarke (*non* Lake), in the shape of the glabella, lateral furrows, characters of cheeks, position of eyes, shape of genal angles, and well-defined lateral border to the head-shield. But the eyes are larger, and the presence of the supra-genal spine indicates its reference to *Calmonia*, and suggests affinity with *Ph.* (*Calm.*) *signifer* Clarke, especially the variety *micrischia* † from Brazil.

* Ulrich, *op. cit.*, 1893, p. 16, t. i, figs. 9, 10, ? 11.

† Clarke, *op. cit.*, 1913, p. 124, pl. vi, figs. 13–16.

Several isolated head-shields (232, 257, 147 Cape Univ.) occur in the collection of the Cape University from Touws River Road, and there is one small complete individual from the same locality (138 Cape Univ.) measuring 14·5 in length from which the characters of the thorax and pygidium have been determined.

The small perfect head-shield (11289 Brit. Mus.) which Salter figured (*op. cit.*, pl. xxv, fig. 10) as a young individual of *Ph. caffer* and Lake (*op. cit.*, p. 210) accepted as such, probably belongs to our new Bokkeveld species, but no supra-genal marginal spine is visible, and the marginal furrow is weaker and less distinct. The course of the lateral furrows on the glabella is not well shown in Salter's figures, but they agree better with *Ph. Lakei* than with *Ph. ocellus*.

As above mentioned, Schwarz believed that the thorax and pygidium, which Lake attributed to the head-shield on which he founded the species *Ph. ocellus*, belong to another species, and from the occurrence of apparently identical portions of the trilobite in the same state of preservation and at the same locality as the head of *Ph. Lakei*, we may suspect that Schwarz was correct. But the evidence is at present inconclusive and unsatisfactory.

As regards the head-shield of *Ph. Lakei*, there is a considerable resemblance to the European species "*Acaste*" *Henni* Richter * of the Upper Coblenzian, but the pygidium in the Bokkeveld species has the segmentation better developed. Indeed those austral species of *Calmonia*, which carry no lateral spines on the margins of the pygidium, appear to be identical in all essential characters with the Lower Devonian group of "*Acaste*" in Europe.

Phacops (*Calmonia ?*) *pupillus*, Lake.

? 1856. *Phacops* (*Cryphaeus*) *africanus* Salter (pars), Trans. Geol. Soc., ser. 2, vol. vii, p. 218, pl. xxv, fig. 8 (11288 Brit. Mus.), *non cet.*

1904. *Phacops pupillus* Lake, Ann. S. Afr. Mus., vol. iv, pt. 4, p. 203, pl. xxiv, fig. 1 (59 S.A. Mus.).

This species was founded on a solitary specimen of an imperfect head-shield from Gamka Poort in the South African Museum (59 S.A. Mus.), but Lake believed that one of the head-shields referred by Salter to *Ph. africanus* (*op. cit.*, pl. xxv, fig. 8) also belonged to it. The true subgeneric position of this specimen is uncertain, but

* Richter, Jahrb. preuss. geol. Landesanst., Bd. xxxvii, 1916, Heft i, p. 252, t. xxv, figs. 13–16 ; t. xxvii, figs. 1–3.

it may belong to *Calmonia*, though the spinose genal angles are rather unusual.

Phacops (*Pennaia*) *Gydowi*, Schwarz.

(Pl. IX, figs. 7, 7*a*; Pl. XI, fig. 2.)

1906. *Phacops* (*Cryphaeus*) *Gydowi*, Schwarz, Rec. Albany Mus., vol. i, pt. 6, p. 396, pl. x, figs. 3, 3*a*, 3*b* (28 Alb. Mus.), 3*c* (26 Alb. Mus.).

In 1906 Schwarz figured a detached head-shield (28 Alb. Mus.) from the Gydo Pass, with some thoracic segments (26 Alb. Mus.) on which he founded this species, but there is another complete specimen (25 Alb. Mus.) in the same collection which was not figured, showing the genal angles to be rounded. There is a good head-shield with 7 thoracic segments attached from the Cockscomb Mountains in the Bloemfontein Museum, and a specially fine complete individual (1167 S.A. Mus.) from Boschluis Kloof, Prince Albert, in the South African Museum, and another from Ceres in the Maritzburg Museum. This material allows us to amplify the original description.

The large eyes, which are well preserved in the specimens at Bloemfontein and Maritzburg, consist of 30–32 vertical rows of lenses with 12–14 lenses in the centre rows. As in the typical species of *Pennaia*, it is the basal glabellar furrows which are the strongest. The genal angles are broadly rounded. The surface of the head-shield, including the doublure, is covered with rather widely-spaced, small, round, low tubercles, with minute granulations between them, and similar tubercles are spread over the thorax. The pleuro-occipital furrow is slightly concave forward and meets the weaker marginal furrow at about 75°. The facial sutures have the posterior branches nearly horizontally directed outwards, but with a slightly sigmoidal course, and cut the lateral margin of the head-shield level with the basal glabellar furrows.

The thorax has rather a wide semi-cylindrical axis, with slight nodular lateral swellings on each axial ring. The pleural lobes are not wider than the axis, and have the pleurae strongly bent down at the fulcrum, which is situated at about two-fifths their length, and the extra fulcral portion is strongly curved backwards and then forwards to its tip, which is truncate, and has the posterior corner angulated or furnished with a very small point, as Schwarz observed; the pleural furrow is strong, nearly straight, and diagonal, and there is a large bevelled articular facet for enrolment. The pygidium is transversely semi-elliptical or semicircular in shape, and has a slowly-

tapering, conical axis, reaching the margin and composed of 6 complete rings and a small terminal joint ; on the lateral lobes there are 5 pairs of broad flattened pleurae, corresponding to the axial rings (with traces of a very narrow, short, sixth pair), separated by strong, straight furrows not reaching the margin ; each pleura bears a very faint, short, straight, non-median furrow near its outer extremity. The lateral margins of the pygidium are provided with 3 pairs of very short, broad, triangular spinose projections, corresponding to the first three pleurae, but behind them the margin is entire and simply rounded.

Dimensions :—

	(Bloemfontein.)	(Maritzburg.)	(1167 S.A. Mus.)
Length of head-shield .	28 mm.	25 mm.	19 mm.
Width „ „ at base.	*c.* 46 „	*c.* 40 „	24 „
Length of glabella .	23 „	22 „	..
Width „ „ at base	15 „	14 „	12 „
„ „ „ at front	..	18 „	..
Length of eye . .	10 „	..	7 „
„ „ thorax . .	..	*c.* 43 „	32 „
„ „ pygidium .	..	*c.* 14 „	13 „
Width „ „ .	..	*c.* 16 „	19 „
„ „ axis at front .	..	..	12 „

Remarks.—This species is very closely allied to *Pennaia pauliana* Clarke * of the Devonian of Ponta Grossa, but it differs in the glabella being rather narrower and longer, the eyes larger, and the pleural furrows on the pygidium only being clearly developed near the outer extremities of the pleurae. The ornamentation also appears to be rather different, and the shape of the extremities of the thoracic pleurae is peculiar to our Bokkeveld species. It is probable that "*Acaste*" *Verneuili* (D'Orb.) from Bolivia † is allied.

Phacops (*Pennaia*) *africanoides* nom. prop. (=*africana* Shand, *non* Salter).

1914. *Pennaia africana* Shand, Trans. Geol. Soc. S. Africa, vol. xvii, p. 24, pl. vi, figs. 1–4 (E 416 Stell. Mus.).

The specimen which Dr Shand described from Osplaats in the Hex

* Clarke, *op. cit.*, 1913, p. 133, pl. v, figs. 18–25.

† Kozlowski, *op. cit.*, 1923, p. 48, pl. iv, figs. 1–6.

River Valley under the name *Pennaia africana* is in the Stellenbosch Museum (E 416), and there is another good head-shield of it in the same collection. Apart from the pygidium there is not much resemblance to the genotype *P. pauliana* Clarke,* for the head-shield might well be referred to *Calmonia*, and much resembles that of *Ph.* (*Calm.*) *Lakei* sp. nov. above described. The thoracic characters also agree closely with typical members of *Calmonia*. The pygidium alone seems to possess the characters of *Pennaia*, but the type specimen is not perfect and the character of the posterior margin is uncertain.

It is unfortunate that the name *africana* was applied to this species, as *Pennaia* is only a subgenus of *Phacops*, and Salter's *Ph. africanus* is a member of the subgenus *Anchiopella*. It appears therefore desirable to alter the name, and we may suggest the substitution of *africanoides* to avoid confusion, while retaining a semblance of Shand's designation.

Phacops (*Phacopina*) *hiemalis* sp. nov.

(Pl. X, fig. 8; Pl. IX, fig. 12 ?.)

Head-shield semi-parabolic, moderately convex from side to side, with its median portion angulated and projecting in front, the anterior margin being excavated on each side of the glabella so as to make a slight re-entrant angle on the edge. Glabella gently convex, subcylindrical, longer than wide, widening very slightly anteriorly, with straight sides and weakly-angulated front end projecting in front of cheeks; frontal lobe unusually long, nearly half the total length of glabella, not projecting laterally; first and second lateral furrows nearly obsolete; first furrows situated far back, very faintly impressed, directed very obliquely backwards; second lateral furrows nearly horizontal, very feebly indicated; third lateral furrows deep, wide, slightly oblique, isolated, short, faintly connected across base of glabella, and scarcely traceable into axial furrows. Axial furrows strong, straight, slightly divergent. Facial sutures with anterior branches long, subparallel, sharply bending in at frontal angles of glabella to meet in middle at angle of about 120°; posterior branches horizontal, gently sigmoidal, parallel to posterior edge of head-shield. Meso-occipital ring rounded, thickened and swollen in middle. Cheeks subtriangular, longer than wide, with strong, broad, pleuro-occipital furrow and shallower lateral marginal furrow separating off well-rounded border. Genal angles blunt, sharply rounded, with lateral and posterior edges of head-shield inclined nearly at

* Clarke, *op. cit.*, 1913, p. 133, pl. v, figs. 18–25.

right angles. Pleuro-occipital ring widening outwards to genal angles. Eyes large, about ¼ length of glabella, elevated on more or less swollen inner portion of cheeks, situated at about one-fifth the width of the glabella from its sides and behind its middle length. Anterior border of head-shield in front of glabella narrow, but deep, having a thick, rounded edge, steeply inclined, with a few larger tubercles on its under surface. Rest of surface of head-shield coarsely granulated.

Dimensions :—

Length of head-shield	. .	34·0 mm.
Width of ,,	. .	50·0 ,,
Length of glabella	. . .	26·5 ,,
Width ,, ,, at base	.	18·5 ,,
,, ,, ,, at front	.	22·0 ,,

Remarks.—The unique specimen (In. 24100) of a head-shield on which this species is founded was obtained from the Winterhoek Mountains near Mount Cockscomb, Uitenhage, and presented to the British Museum in 1858 by Dr. Atherstone. It is in rather an unusual state of preservation, and the curious wrinklings on the surface of the whole head-shield seem due to the natural shrivelling of the epidermal cuticle of the carapace. In general characters it much resembles *Phacopina devonica* Ulrich,* which occurs in the Bolivian Devonian, but the glabella is more cylindrical, the first lateral furrows rather further back, the front margin is more angulated, and the meso-occipital ring more thickened. *Ph. brasiliensis* Clarke † from the Maecuru Sandstone, which is taken by M'Learn ‡ as the genotype of *Phacopina*, is regarded by Kozlowski as allied to *Ph. devonica*, but Clarke § considers it as belonging to the same group as *Ph.* (*Phacopidella*) *correlator* Clarke ‖ from the Gaspé and Oriskany Sandstones, while he puts *Ph. devonica* in the present author's group or division *Metacryphaeus.* Kozlowski,¶ however, maintains that the diagnosis does not fit it.

Dienst ** has attributed the Coblenzian species, *Acaste Schmidti*

* Ulrich, *op. cit.*, 1893, p. 21, t. i, figs. 14*a*, *b*, 15 ; Kozlowski, *op. cit.*, 1923, p. 49, pl. iv, figs. 7–14.

† Clarke, Archiv Mus. Nac. Rio de Janeiro, vol. x, 1890, p. 16, t. i, fig. 1.

‡ M'Learn, Ottawa Naturalist, vol. xxxii, 1918, p. 33.

§ Clarke, Mem. 9, New York State Mus., pt. 1, 1908, p. 226, pl. x, figs. 17, 18.

‖ Clarke, " Foss. devon. Parana," 1913, pp. 152, 153.

¶ Kozlowski, *op. cit.*, 1923, p. 51.

** Dienst, Jahrb. k. preuss. geol. Landesanst., Bd. xxxiv, Heft 1, 1914, p. 545.

Richter, to the subgenus *Phacopina,* but the correctness of this reference may be questioned.

There is a pygidium (243 Cape Univ.) from Touws River Road, Upper Hex River Valley, in a different state of preservation to the above-described head-shield, but it may possibly belong to the same species, on the strength of its resemblance to the pygidium of *Ph. devonica* figured by Kozlowski * from Bolivia. Our specimen is partly hidden by matrix, but it is seen to be subtriangular in shape and convex from side to side and pointed behind; the axis is broad, subcylindrical, very slightly decreasing in width to its blunt termination, and is annulated for its whole length by 9 complete simple rings; the pleural lobes are composed of 6–7 well-rounded, convex, raised, simple, unfurrowed pleurae, gently curved back, but the last 2–3 are weak, indistinct, and subparallel; all the pleurae end abruptly within the edge of the pygidium, but there is no definite border. The interpleural furrows are strong and deep.

Dimensions :—

Length of pygidium . . .	*c.* 23 mm.
Width of ,, . . .	29 ,,
,, of axis at front end . .	13 ,,
Length of axis	19 ,,

Phacops (*Bouleia ?*) *Sharpei* sp. nov.

(Pl. IX, fig. 6; Pl. X, fig. 9.)

Pygidium transversely semicircular; margin entire. Axis broad, conical, tapering rather rapidly to blunt tip, not reaching posterior edge, about one-third the width of pygidium at anterior end, gently convex, annulated for whole length with 7–8 complete rounded rings, separated by wide intersegmental furrows. Pleural lobes very slightly arched, with fulcrum situated at less than one-third their width on front edge, and with long, oblique, extra-fulcral edge meeting posterior margin at lateral angle level with fourth or fifth axial ring; pleurae 6, widely separated, simple, corresponding with axial rings, very slightly curved, strongly elevated, convex, dying out some distance inside margin, leaving an undefined rather wide border one-third or one-fourth the width of the pleural lobes; interpleural furrows deep, as wide as pleurae, rounded.

Surface of whole pygidium ornamented with close, very coarse granulations.

* Kozlowski, *op. cit.*, 1923, pl. iv, figs. 13, 13*a*.

Dimensions (198 Cape Univ.) :—

Length of pygidium . .	14	mm.
Width (max.) of pygidium .	26	,,
Length of axis . . .	11	,,
Width of axis at front end .	9	,,

Remarks.—There is only one complete specimen of a pygidium (198 Cape Univ.) in the collection of the Cape University from Touws River Road, Upper Hex River Valley, and an imperfect smaller pygidium (I 858 Brit. Mus.) in the British Museum from the Keurbooms River, Plettenberg Bay, the latter only showing part of the axis and the posterior portions of the pleural lobes. There is no marginal furrow marking off the border, which, however, posteriorly, forms a definite, smooth, wide band outside the ends of the pleurae. The pleurae are simple, and show no clear trace of any furrow. We may compare the pygidium of the Bolivian species *Phacops* (*Bouleia*) *Dagincourti* Ulrich,* with this Bokkeveld species, which it resembles in general shape, number of segments, and simplicity of the pleurae.

Note.—There are in the British Museum two small complete trilobites labelled "*Phacops latifrons* Bronn. Devonian, Cape of Good Hope. 44976. Morris Coll. Bt. of Krantz." They are in a completely different state of preservation to the other undoubted Bokkeveld specimens, and it has been suggested with much probability that there has been some mistake in the locality, and that they come from the Devonian of the Eifel. They represent two distinct species, both of which bear a certain affinity to *Ph. rana* Green, and to *Ph. Salteri* Kozlowski,† which occurs in the Devonian of South America. But it does not seem likely that either of these British Museum specimens came from South Africa, and a description of them is therefore unnecessary.

Typhloniscus Baini, Salter.

1856. *Typhloniscus Baini*, Salter, Trans. Geol. Soc., ser. 2, vol. vii, p. 221, pl. xxv, fig. 14 (11292 Brit. Mus.).

1904. *Typhloniscus Baini* Lake, Ann. S. Afr. Mus., vol. iv, pt. 4, p. 213, pl. xxv, figs. 8, 9 (63 S.A. Mus.).

Lake gave rather a short description of this species and did not

* Ulrich, Neues Jahrb. f. Miner., Beil. Bd. 1892, p. 23, pl. i, figs. 16*a–c* ; Kozlowski, *op. cit.*, 1923, p. 56, pl. vi, figs. 7, 7*a*, *b*, 8, 8*a–c*.

† Kozlowski, *op. cit.*, 1923, p. 54, pl. vi, figs. 1–6.

mention that there is a coarse tuberculation all over the glabella and cheeks as seen in No. 1659 S.A. Mus., and in others (117, 120) in the collection of the Cape University, for in the specimen (41 S.A. Mus.) which he figured from Gamka Poort the surface is rubbed.

In another specimen of the thorax and pygidium (458 S.A. Mus.) from Koudeveld Berg, the pygidium is seen to be semicircular with an entire margin; there are +6 rings on the axis, and 5–6 pleurae on the lateral lobes. In the British Museum there is a thorax showing 10 segments attached to an imperfect pygidium (11302 Brit. Mus.) and named by Salter. This pygidium is better preserved and merits some description: the axis only shows 4 rings, of which the first 2 only are distinct, and the lateral lobes are composed of only 4 pleurae, of which the first 3 pairs are rounded, strongly convex, gently arched back, and subequal, but the fourth pleurae are much smaller and shorter, and run straight back nearly parallel. There is a good head-shield in the Albany Museum (2561 Alb. Mus.) which exhibits some interesting and peculiar features, a narrow extra- or infra-marginal band running round the anterior edge in front of the narrower rounded border; it seems to arch forward on each side of the middle part, which is reduced in width and recessed, and it possesses on its outer edge a row of small tubercles of about 6 on each side, and on its inner edge a row of small pits with raised lips lying in the groove separating it from the border, and in more than one place there seems to be a fine radial pitting on this curious infra-marginal band or doublure. The head-shield to which it is attached measures 17 mm. in length and 30 mm. in width, and the band is only 2 mm. wide in its broadest part. Its nature is somewhat doubtful.

Homalonotus (*Burmeisteria*) *Herscheli*, Murchison, emend.

1839. *Homalonotus Herscheli* Murchison, Silur. Syst., p. 652, pl. vii, *bis.*, fig. 2.

1856. *Homalonotus Herscheli* Salter (pars), Trans. Geol. Soc., ser. 2, vol. vii, p. 215, pl. xxiv, figs. 1*a*–*c* (11276, 11294 Brit. Mus.), 2 (11277 Brit. Mus.), 6 (11281 Brit. Mus.), 7*a*–*d* (11282 Brit. Mus.) (*non* figs. 3, 4, 5, 8). [Fig. 1 is a restoration from specimens Nos. 11294, 11276 Brit. Mus.]

1904. *Homalonotus Herscheli*, Lake (pars), Ann. S. Afr. Mus., vol. iv, pt. 4, p. 214, pl. xxvi, figs. 3*a*, *b* (30 S.A. Mus.) *non* figs. 1, 2.

1906. *Homalonotus Herscheli* Schwarz (pars), Rec. Albany Mus., vol. i, pt. 6, p. 383, pl. ix, fig. 3 (*non* pl. viii, fig. 8).

? 1906. *Homalonotus lex* Schwarz (pars), *ibid.*, p. 389, pl. ix, figs 4*a*, *b* (1462 and 1 Alb. Mus.).

1918. *Homalonotus* (*Burmeisteria*) *Herscheli*, Reed, Geol. Mag., Dec. vi, vol. v, pp. 314, 324.

Murchison's original specimen consists of a thorax and pygidium from the Cedarberg, and he was apparently ignorant of the head-shield. There has been much confusion and irregularity in the use of this specific name. As mentioned by the present author (1918, *op. cit.*), Salter's figures represent more than one variety or species, and the typical form of the head-shield corresponding with his description is that illustrated by his figures 1*a–c* (11276 Brit. Mus.); the occipital ring, however, is missing in this specimen, and has been restored from another head-shield (11294) from the same locality, Leo Hoek, in the same collection, and it shows precisely the same characters in the glabella and other parts as the type. Salter's description of the characters of the glabella is sufficient, except that it should be added that the anterior end is rounded, not abruptly truncate as in some allied species or varieties. The facial sutures unite in front on the upper surface of the head-shield in a broad ogive, meeting in the middle in a point, and not forming a simple continuous curved commissure. The apiculus of the rostral shield is a rounded, hook-like, pointed projection, curving downwards.

These features are well seen in the specimen numbered 52053 from Leo Hoek in the British Museum, while in the specimen No. 11294 (8) in the same collection the occipital ring is preserved and shows the characters illustrated by Salter in his figures 1*a*, 1*b*; there is a small median tubercle on the meso-occipital portion, with another small one on each side just inside the axial furrows, while on the pleuro-occipital portion there are 3 tubercles or spine-bases on its outer part, successively increasing in size; (these are well seen in a specimen (1432 Alb. Mus.) in the Albany Museum); probably the outermost two rose into short spines, but they are broken off. No other tubercles or spines occur on the head-shield, the whole of which is covered with a fine ornamentation consisting of rather large, subequidistant, well-spaced granules of equal size, between which is a very minute, close, general granulation. There are subcircular, depressed, well-marked paraglabellar areas, slightly swollen in the middle, and definitely circumscribed, on each side of the basal lobes of the glabella, which they slightly excavate, and they have only a minute granulation on them,

finer than that on the rest of the head-shield. Salter termed them the "oval flattened spaces." The ogival junction of the facial sutures in the middle in front of the glabella forming an obtuse angle at the base of the apiculus is a characteristic of the species, and is well seen in a head-shield (66 Alb. Mus.) in the Albany Museum.

The pygidium (11282 Brit. Mus.) figured by Salter (*op. cit.*, pl. xxiv, figs. 7*a–d*) as belonging to *H. Herscheli*, has precisely the same ornamentation as the above-mentioned head-shields, and also possesses a small median tubercle on the axial ring like that on the meso-occipital ring and a similar lateral one on each side, except on the third ring, which seems to have none. The pleural lobes which are weakly separated from the axis (the axial furrows being only slightly impressed) are steeply inclined on each side, and show 12–13 well-marked pleurae corresponding with the axial rings which number 14–15, but the posterior part of the axis and pleural lobes are smooth, the segmentation being nearly or quite obsolete. The tip of the pygidium descends rather rapidly to the margin, as is shown in profile in Salter's figure, 7*b*, and is a characteristic feature. The end of the pygidium is acutely pointed. The strong transverse convexity, the pointed posterior end, the long triangular pointed terminal plate of the doublure, the ornamentation of the whole surface, and the obsolescence of the posterior segmentation are distinctive and typical characters of the species. On several of the pleurae a small tubercle occurs, but not at the same point.

Schwarz (*op. cit.*) tried to sort out Salter's and Lake's specimens from the published figures, but he was not altogether successful in the attempt, and he believed that several species had been included under the one name.

With regard to the thorax, which should be associated with the head-shields and pygidia above referred to *H. Herscheli*, the one figured by Salter (*op. cit.*, fig. 4) from Gydo Pass (11279 Brit. Mus.) is much like Murchison's original figure and Frech's *H. perarmatus*, which is here regarded as a variety. The tubercles (spine-bases) on the pleurae and axis seem too coarse and large to belong to the typical head-shields. But probably the two thoracic segments (11281 Brit. Mus.) represented by Salter's figure 6, having small lateral tubercles on the axis, belong to the type of head-shield which he figured.

Salter's figured specimen (11280 Brit. Mus.) of two thoracic segments (*op. cit.*, fig. 5) is probably referable to Lake's species *H. quernus* described below, and the pygidium (11283 Brit. Mus.) (*op. cit.*, fig. 8) probably belongs to *H. noticus* Clarke, var. nov. *africana* (see p. 184).

In the Stellenbosch Museum there is a good example (C 5) of a small head-shield (locality unknown), 31 mm. in length, agreeing in nearly all particulars with the second figured specimen (11277 Brit. Mus.) of Salter's plate (*op. cit.*, pl. xxiv, fig. 2), and it shows the lower surface of the anterior part of the head-shield very well. The distinctly upturned preglabellar area, the short unciform apiculus, the acutely triangular rostral shield, the broad plate-like doublure forming a large triangular shield on each side of the rostral shield but narrowing laterally very rapidly (as in *H. noticus* Clarke), the urceolate shape of the glabella, the 3 pairs of glabellar furrows, the paraglabellar areas, and the prominent eyes on the swollen cheeks are just as Salter illustrates, and a comparison with his figured specimen proves that they precisely agree. But there is no trace of a median tubercle or any other tubercle on the meso-occipital ring, and the pleuro-occipital portions are broken and missing. There is a median longitudinal ridge along the rostral shield bisecting its surface, which seems absent in Salter's type. Of more importance is the fact that the transverse union of the facial sutures is straight and shows no median angulation, though this also may be due to immaturity. The ornamentation of the surface seems to be indistinguishable from that of the typical *H. Herscheli.*

We may draw attention to the resemblance of the anterior part of the head-shield with its upturned snout, rostral shield, apiculus and doublure, to *H. noticus* Clarke,* from the Devonian of Brazil, but the glabella is quite different.

The species which Schwarz named *H. lex* (*op. cit.*, p. 389, pl. ix, figs. 4*a*, 4*b*) was founded on 3 large thoracic pleurae, and is a most unsatisfactory one, being imperfectly defined. It seems to be an unnecessary species, for the figured specimens may be probably attributed to *H. Herscheli.* The first figured (fig. 4*a*) and mentioned specimen (1462 Alb. Mus.) consists of only 3 thoracic pleurae, each having a pair of small tubercles inside the fulcrum, with an extra third tubercle on the second pleura. The tip of the pleurae, which Schwarz describes as pointed, is merely truncated. The second figured specimen, fig. 4*b* (1 Alb. Mus.), has a pair of lateral tubercles or spine-bases on nearly every axial ring of the thorax (which is convex), and also occasionally a small median one, while on each pleura there is a single large tubercle or pair of closely-placed small tubercles inside the fulcrum. On some of the axial rings of the pygidium of

* Clarke, *op. cit.*, 1913, p. 89, pl. i, figs. 1, 2; pl. ii, figs. 1–13. R. and E. Richter, Centralbl. f. Miner., etc., Jahrg. 1917, pp. 114–120, text-figs. 3*a*–*c*.

this specimen (of which Schwarz only figured from thoracic rings) there is likewise a pair of lateral tubercles. The fine ornamentation of the surface is like that of *H. Herscheli.*

Another fragment of a thorax (13 Alb. Mus.) consisting of 9 segments, has a pair of lateral spine-bases on each axial ring, regularly arranged, but none on the pleurae ; the fine ornamentation consists of granules of two sizes as in *H. Herscheli.* In another (9 Alb. Mus.) the tubercles or spine-bases on the thorax are less regularly developed, and some of the pleurae carry one or two spine-bases. Thus we see that there is considerable variation in the number and disposition of the spine-bases, and it does not appear that we can attach primary importance to them, at any rate to those on the thorax.

H. Herscheli is the type of the section or subgenus *Burmeisteria,* and its characters have been discussed by the author on a previous occasion,* and a precise definition given.

Homalonotus (*Burmeisteria*) *Herscheli*, Murchison, var. nov. *rectisuturalis.*

(Pl. X, figs. 3, 7.)

1904. *Homalonotus Herscheli* Lake, Ann. S. Afr. Mus., vol. iv, pts. 4, 9, pl. xxv, fig. 1 (29 S.A. Mus.).

There is one large, nearly perfect head-shield with the shell preserved in the collection of the Cape University (314 Cape Univ.) from Bokke Rivier, seventeen miles from Touws River, on the road to Ceres, which can hardly be separated specifically from *H. Herscheli,* but certainly constitutes a variety remarkable for the shortness and breadth of its glabella and other features. Internal casts of the head-shield of this form (7193 S.A. Mus.) look still more unlike the typical *H. Herscheli.* The head-shield is transversely semicircular, and is more or less convex from side to side. The glabella is subquadrate, wider than long, or as wide as long, scarcely urceolate, decreasing slightly in width anteriorly, with the frontal lobe scarcely expanding ; the front end is truncated, but the lateral furrows are developed as in the typical form. In the well-preserved example from Bokke Rivier the basal lobes carry a weak, median, horizontal, transverse ridge, which does not seem due to an injury, as it is symmetrically developed on each side. The paraglabellar areas are subcircular and cut into the sides of the basal lobes. The cheeks are swollen, and their characters agree with the typical form. The facial sutures unite in front

* Reed, Geol. Mag, Dec. vi, vol. v, 1918, pp. 314, 324.

by a simple, transverse, scarcely-arched suture without any median angulation, and the rostral apiculus is very short, blunt, and broadly triangular, and bears small tubercles or large granules on it, as also on the rounded edges of the free cheeks where they are closely aggregated, whereas the general surface of the head-shield has only a fine general granulation, with small, sharp tubercles scattered about as in the type form. The marginal furrow to the free cheeks is obsolete or very shallow and broad. In one specimen (C 6 Stell. Mus.) from an unknown locality, the pleuro-occipital ring is preserved and is seen to widen and swell up laterally and bear 2–3 large spine-bases at about half its length. The genal angles are broadly rounded. The meso-occipital ring is smooth.

Dimensions :—

	(314 Cape Univ.	(7193 S.A. Mus.)	(C 6 Stell. Mus.)
Length of head-shield (minus occipital ring)	55·0 mm.	42·0 mm.	50·0 mm.
Width of head-shield .	92·0 ,,	60·0 ,,	*c.* 80·0 ,,
Length of glabella .	41·0 ,,	27·0 ,,	31·0 ,,
Width ,, at base	44·0 ,,	31·0 ,,	35·0 ,,
,, ,, at front	37·0 ,,	24·0 ,,	27·0 ,,

In those specimens of the head-shield preserved only as internal casts, such as one (7193 S.A. Mus.) from the Cold Bokkeveld, and another (C 6 Stell. Mus.) from an unknown locality, the lateral furrows on the glabella are indistinct and the ornamentation is, of course, not visible. An imperfect head-shield in the Albany Museum (2552 Alb. Mus.) shows not only the transverse straight suture and apiculus, but also the rostral shield on the inferior surface. This rostral shield is almost an equilateral triangle, and there is no median ridge running back from the apiculus. The general ornamentation of the head-shield is seen to be the same as in the typical *H. Herscheli,* but the coarse granulation on the apiculus is as described above in other specimens of this new variety *rectisuturalis.* The broader, more equilateral, and shorter rostral shield is another distinction from the type form of the species.

There is a complete, but probably young individual in the Stellenbosch Museum (C 1 Stell. Mus.) from an unknown locality, which, though for the most part in the condition of an internal cast, yet has

portions of the shell attached to the cheeks, the pleurae, and the pygidium, and this shows a close, nearly uniform granulation, unlike that in the typical *H. Herscheli*, the larger granules being scarcely differentiated. The head-shield and glabella show, however, characters which are indistinguishable from other examples of *H. Herscheli* var. *rectisuturalis*. The thorax, moreover, is interesting owing to the great width of the axis, which, at its front end, is one and a half times the basal width of the glabella, while the pleural lobes are less than half the width of the axis at its anterior end. There seems to be a complete absence of tubercles or spine-bases on the thorax and pygidium, but on the head-shield the pleuro-occipital ring near the genal angles is swollen and bears two large, stout spine-bases. The pygidium has the usual shape of *H. Herscheli*, being acutely triangular with strongly arched-down lateral lobes, which show pleurae to the number of 10–12 on their whole surface, though the posterior ones are weaker; the axis has more than 12 rings, but the posterior part is abraded; the doublure is precisely like that of *H. Herscheli*.

Dimensions :—

Length of head-shield	+17 mm.
Width of ,, . . .	40 ,,
Length of glabella	15 ,,
Width of ,, at base . .	17 ,,
,, ,, ,, at front . .	14 ,,
Length of thorax	43 ,,
Width of thoracic axis at front . .	25 ,,
,, ,, ,, at posterior end	14 ,,
Length of pygidium	+22 ,,
Width of ,, ...	20 ,,
,, ,, axis at front . . .	14 ,,

The poor specimen of a head-shield (29 S.A. Mus.) from Ezelfontein which Lake (*op. cit.*) referred to *H. Herscheli*, was thought by Schwarz * to belong to another species, but probably it is referable to the above-described variety.

Homalonotus (*Burmeisteria*) *Herscheli*, Murchison, var. *colossus*, Lake.

1904. *Homalonotus colossus* Lake, Ann. S. Afr. Mus., vol. iv, pt. 4, p. 216, pl. xxviii, figs. 1–3 (364 S.A. Mus.).

Clarke † was of the opinion that no specific characters existed in

* Schwarz, Rec. Alb. Mus., vol. i, pt. 6, 1906, p. 384.

† Clarke, *op. cit.*, 1913, p. 95.

this species of Lake's by which it could be distinguished from *H. Herscheli*, apart from its great size. But it seems that it may be worthy of being regarded as a variety, for there are more numerous (5) tubercles or spine-bases on the pleuro-occipital ring, and the thoracic segments bear 2 pairs of lateral spines or tubercles. An examination of Lake's type yields no further details than Lake described, but in the collection of the Cape University there are portions of 2 head-shields in a good state of preservation (309, 310) from Bokke Rivier, seventeen miles from Touws River, on the road to Ceres, which may be referred to the same form. The pleuro-occipital ring bears 4 or 5 spine-bases of subequal size, those in No. 309 forming 2 pairs, of which the outer pair is the larger ; the minute ornamentation of the head-shield is precisely the same as in *H. Herscheli*, but the larger granules become more numerous and more closely placed on the rounded border, and the course of the transverse suture in front of the pre-glabellar area seems to be a simple broad curve, as in the variety *rectisuturalis*. The shape and lobation of the glabella (with the exception that the front end is more abruptly truncated), the paraglabellar areas, the eyes and the cheeks seem to be identical with *H. Herscheli*. The specimens indicate a head-shield 80–85 mm. in length and 150–160 mm. in width.

There is a large pygidium (317 Cape Univ.), also from Bokke Rivier, in the collection of the Cape University, preserved in a nodule and complete except for the tip, which is broken off, and for the lateral edges, which are hidden by the matrix. From its unusual size and occurrence at the same locality as the above-mentioned head-shields in this collection, it may probably be associated with the variety *colossus*, though it may only represent a specially large individual of the type form.

The first 9 rings of the axis of this specimen are well preserved, and are interesting because they show the diverse and unsymmetrical arrangement of the tubercles and spine-bases. The first 3 axial rings, and the 5th to the 8th inclusive, bear a large lateral spine-base on the left side, with a smaller one outside it on the first 3, but only the smaller one on the 4th ring. On the right side of the axis there is a corresponding large lateral spine-base on the first 5 rings and on the 7th, but not on the 6th, 8th, or 9th, and the smaller outer tubercle is only present on the first 3. There is a median pair of closely-placed spine-bases or large tubercles on the 2nd and 4th rings, but on the 6th, 8th, and 9th only the left-hand one is present, and it is smaller. The 1st ring has no

distinct median tubercle, but there is a rather unsymmetrical pair of widely-separated smaller tubercles. The posterior 7–8 rings on the axis seem devoid of tubercles or spine-bases, and successively become weaker, and the axial furrows which are distinct, though shallow, alongside the anterior 9 rings are almost obsolete alongside these last 7–8, and probably disappear completely before the tip is reached, but this part is missing. The first 4 pleurae bear a small tubercle or spine-base close to the axial furrows on the left side, and there is one large spine-base (and a smaller one inside it) further out on the 2nd pleurae. On the 3rd and 4th pleurae a small tubercle is situated near the axial furrow, but there is none on the 5th; the 6th, however, has a larger one further out. The remaining pleurae on the left side seem devoid of tubercles, and successively become weaker, the posterior ones being indistinguishable, as is well seen on the right side of the pygidium near its tip, where there are no traces of pleurae on the lateral lobes. The pleurae on the right side are mostly hidden, but on the 6th pleura there is a small tubercle near the axial furrow, and on the 7th a similar one with a larger one situated a little further out. The axis tapers rapidly at about 1 in 2 in the anterior part, but rather more slowly behind the 9th segment. The first 10 pleurae correspond precisely with the axial rings, and are gently convex, of uniform width and separated by narrow grooves. The whole surface of the pygidium is covered with small, round, sharp, isolated, large granules, rather widely separated, and of equal or subequal size, with a minute general granulation between them, as in the typical *H. Herscheli.*

The length of this broken pygidium is +70 mm., and the width of the axis at its front end 42 mm., but the whole pygidium must have measured over 80 mm. in length when perfect, and the total number of rings on the axis must have amounted to at least 20, while at least 12 pleurae are distinctly developed on the flanks, the posterior fourth or fifth part of the pleural lobes being smooth and devoid of segmentation.

Homalonotus (*Burmeisteria*) *Herscheli* Murch. var. nov. *fusiformis.*

1904. *Homalonotus Herscheli* Lake (pars), Ann. S. Afr. Mus., vol. iv, pt. 4, p. 214, pl. xxvi, figs. 2*a*, 2*b* (21 S.A. Mus.).

The much elongated, convex, semifusiform, pointed pygidium from Gamka Poort, which Lake figured and attributed to *H. Herscheli,* does not agree with the type, and must certainly be separated from this

species. It is, however, to this specimen rather than to Salter's figured types in the British Museum that part of Lake's description of the pygidial characters applies. For he states that "the tail forms a long triangle, is extremely convex, and ends in a sharp point; it is in fact half of a cone." The pleural lobes are slightly arched inwards underneath, and the terminal point is very acute and produced into a rounded mucro. The axial furrows are practically obsolete, and the axis is very broad and scarcely rises above the general convexity of the surface; it shows 13–14 complete rings before fading away into the non-segmented posterior portion of the pygidium. The pleural lobes curve down very steeply on each side, bending in slightly underneath, and only show traces of 5–7 broad, flat pleurae on the anterior part, while their posterior parts are smooth, the pleurae being obsolete. The pygidial segments are devoid of tubercles, except a small median one on the 3rd axial ring; but on the thoracic segments, which have a similar broad axis and strongly arched down pleurae, there seems to be a lateral tubercle on each side of the axial rings. A similar type of pygidium occurs in the British Museum (45080), and there are examples also in the Albany Museum.

The sharply-pointed pygidium of the Hunsruckian species from Belgium which has been recently described by Asselberghs as *H. Mallieuxi*,* possesses a similar mucro to our Bokkeveld form, but has a more defined and narrower axis.

Homalonotus (*Burmeisteria*) *Herscheli* Murch. var. nov. *Grahami.*

1906. *Homalonotus Herscheli* var. Schwarz, Rec. Albany Mus., vol. i, pt. 6, p. 38, pl. viii, fig. 8 (2554 Alb. Mus.).

Head-shield narrow, triangular, more or less pointed in front, the lateral margins converging anteriorly at an acute angle and the cheeks strongly bent down. Genal angles broadly rounded. Glabella oblong, very slightly urceolate, truncated abruptly at front end, with 3 pairs of lateral furrows all sloping obliquely backwards and more or less distinct; the basal lobes do not project at the sides. Paraglabellar areas subcircular, well-defined, deeply cutting into sides of basal lobes. Meso-occipital furrow strongly arched forward and angulated in middle. Meso-occipital ring simple. Pleuro-occipital ring with 1 or 2 strong tubercles or spine-bases near genal angles. Facial sutures with anterior branches nearly straight, con-

* Asselberghs, Bull. Soc. Belge Geol., etc., vol. xxxiii, 1923, p. 29, pl. i, figs. 7–9.

vergent, connected by straight (or very slightly angulated) transverse suture ; posterior branches cutting genal angles behind widest curve. Rostral shield narrow, triangular, very sharply pointed behind, with weak, median, longitudinal ridge running back from low apiculus. Eyes small, elevated, situated opposite 2nd lateral lobes, and distant from glabella about half its width. Ornamentation of surface composed of large scattered sharp granules, with minute granulation between.

Remarks.—Schwarz figured a good example (2554 Alb. Mus.) of this form from Ezelfontein, which he rightly thought was separable from the typical *H. Herscheli.* The glabella is more oblong in shape and relatively longer; the whole head-shield is narrower, more arched down at the sides, and more pointed in front; the meso-occipital furrow is more sharply bent forward in the middle; the paraglabellar areas invade the basal lobes more deeply, and the minute ornamentation is slightly different, the tubercles being more numerous and closer together; the transverse suture is typically straight and not angulated. A specimen (7188 S.A. Mus.) of a similar head-shield from Wolfaardt's Farm, Ceres, may be referable to this variety.

Homalonotus (*Burmeisteria*) *Herscheli* Murch. var. nov. *bituberculata.*

(Pl. X, fig. 2.)

Head-shield subparabolic, bluntly-pointed anteriorly, with the sides converging at about 60°, but becoming more semicircular with age, gently convex from side to side, with the free cheeks descending more steeply. Glabella suboblong, widest at base, slightly constricted at half its length, and subcylindrical in front, the axial furrows at first converging and then running forwards subparallel to the rather abruptly truncated anterior end of glabella; lateral furrows more or less distinct; the anterior pair oblique, short, directed backwards, situated at about one-fifth the length of glabella; the second pair short, oblique, situated at half length of glabella in front of eyes at constriction of glabella; basal pair oblique, curved, long, situated at one-third length of glabella from base, incompletely marking off large basal lobes. Paraglabellar areas very faint, not invading basal lobes. Meso-occipital furrow strong, slightly arched forward in middle and at sides. Meso-occipital ring broad, rounded, with a large lateral spine-base on each side near axial furrows. Cheeks bearing prominent rounded boss, carrying small elevated eyes at about

half length of glabella, and distant about half its width from axial furrows. Genal angles rather abruptly rounded. Pleuro-occipital furrow very shallow, broad, and faint; pleuro-occipital ring swollen towards genal angle and bearing 2–3 spine-bases. Marginal furrow obsolete. Pre-glabellar area broad, flattened, slightly bent up. Apiculus short, triangular, bent down. Facial sutures with anterior branches subparallel, bending abruptly in at anterior ends to unite in a straight transverse suture. Surface finely granulated, with a few scattered larger granules.

Dimensions:—

	(I 254 Brit. Mus.)	(B 4 S.A. Mus.)
Length of head-shield . .	41·5 mm.	34·0 mm.
Width of ,, . .	*c*. 68·0 ,,	*c*. 56·0 ,,
Length of glabella	30·0 ,,	23·5 ,,
Width ,, ,, at base .	30·5 ,,	23·0 ,,
,, ,, ,, at front .	20·5 ,,	16·0 ,,

Remarks.—This type of head-shield, of which the best specimen (I 254 Brit. Mus.) is from an unknown locality, somewhat resembles the variety *sodalis* described below, but the course of the axial furrows gives the glabella a distinctive shape, much like *H. quernus*, and the glabella is also relatively longer. The pair of lateral tubercles on the meso-occipital ring is also characteristic, though they may disappear with age, and the minute ornamentation is closely like that of *H. Herscheli*, and not like that of the variety *rectisuturalis*. The fact that the paraglabellar areas do not excavate the sides of the basal lobes increases the basal expansion of the glabella. Associated with the head-shield (B 4 S.A. Mus.) from Hoenderfontein are some pygidia in the same state of preservation, and of proportionate size to match the above-described head-shield. The best-preserved specimen is acutely triangular, ending behind in a short, sharp, subcylindrical mucro, and is very strongly convex from side to side, the pleural lobes descending with increasing steepness posteriorly and slightly compressed or hollowed out towards the end. The axis is distinctly but weakly defined, without any marked independent convexity, and it is composed of 16–17 complete rings and a short, terminal, non-annulated portion forming the blunt tip which ends some distance from the tip of the pygidium, the postaxial portion descending rather

suddenly to the mucro. The shape of the axis is conical, but it tapers more rapidly for the first 8–9 rings than it does posteriorly, as in *H. agrestis* Schwarz. On the first 6–7 rings there is a large, lateral spine-base on each side. The pleural lobes, which are very steep, only show 6–7 faint, low pleurae, some of which carry one or more tubercles; all the pleurae die out before reaching the lateral edges of the pygidium, which are sharp; the posterior third of the pleural lobes seems to be smooth, and the pleurae here are nearly or quite obsolete. On the anterior edge of each of the pleural lobes there is a large, triangular, inclined, articulating surface, rapidly widening to the lateral angle, and bearing a sharp diagonal furrow.

This type of pygidium is much like *H. Herscheli* var. *fusiformis*, but the axis and pleurae in the present form carry spine-bases, and the whole shape is less acutely pointed and tapering more slowly to the tip, so that it resembles in outline and obsolescence of pleurae *H. Clarkei* Kozl.,* from which it seems only distinguishable by possessing spine-bases.

Dimensions of pygidium (B 4 S.A. Mus.) :—

Length	31 mm.
Width	24 „

Homalonotus (*Burmeisteria*) *Herscheli*, Murchison, var. *perarmata*, Frech.

1856. *Homalonotus Herscheli*, Salter (pars), Trans. Geol. Soc., ser. 2, vol. vii, pl. xxiv, fig. 4 (11279 Brit. Mus.).

1897–1902. *Homalonotus perarmatus* Frech, Lethaea Geognostica, vol. i, Palaeoz., Bd. 2, p. 218, text-fig.

1906. *Homalonotus agrestis* Schwarz, Rec. Albany Mus., vol. i, pt. 6, p. 386, pl. ix, figs. 2*a*, *b* (1457 Alb. Mus.).

? 1906. *Homalonotus horridus* Schwarz, *ibid.*, p. 385, pl. ix, figs. 1*a*–*c* (1444 Alb. Mus.).

Frech founded his species *H. perarmatus* on a complete specimen, from "Saron, Cape Colony," but gave no description of it. Lake (*op. cit.*, 1904, p. 214) regarded it as only a variety of *H. Herscheli*, and Schwarz (*op. cit.*, p. 384) thought his *H. horridus* might be identical with Frech's species. With the latter view I rather hesitate to agree,

* Kozlowski, *op. cit.*, 1923, p. 24, pl. i, figs. 14, 15.

because of the shape of the pygidium and of the pygidial axis in *H. perarmatus*, which agrees in this respect with *H. agrestis* Schwarz, but not with *H. horridus* Schwarz. For the pygidium has a broadly triangular shape, with its lateral margins slightly excavated, so that it tapers at first rather rapidly, and then at about half its length more slowly to its tip, which is somewhat produced behind. The axis similarly tapers in its anterior half more rapidly than it does in its posterior portion. The doublure is broad at the tip but narrow at the sides. The minute ornamentation is that of the typical *H. Herscheli*.

In the South African Museum there is an excellent specimen (7194 S.A. Mus.) from the Cold Bokkeveld, of a nearly complete thorax, possessing 10 segments, and part of an eleventh one in front, attached to a pygidium, of which only the tip is missing. The thorax has a very wide axis, more than twice the width of the pleural lobes at its front end ; the axis is somewhat flattened in the middle between the lateral tubercles, but outside them is arched down rather steeply to the axial furrows, which are distinct but shallow ; the pleural lobes are bent down almost vertically on each side. The tubercles are rather irregularly disposed, but there is a lateral line of large tubercles down each side of the axis, though the right one on the 3rd ring is absent, and the left tubercles on the 2nd, 3rd, and 7th are smaller than those on right side. There is a median tubercle on the 4th, 6th, 7th, 9th, 10th rings, and a small pair on the 8th one. The 1st and 2nd pleurae have no tubercles; the 3rd and 4th have one large one on the fulcrum; the 5th has a smaller inner one as well; the 6th, 7th, and 9th have 3 tubercles, of which the two outer ones are much larger, but all are within the fulcrum ; the 8th has only two large ones, and the 10th two small ones. The pygidium has large lateral tubercles on the first 5 axial rings, but the right tubercle on the 1st ring is missing, and so is the 4th one on the left side. The pleural lobes have a tubercle at half their length only on the 2nd pleura on the right side, but on the left side on the 3rd, and another on the 4th, and there are some much smaller ones on some of the posterior, narrow, faintly-marked, axial rings, and on the indistinct posterior pleurae. The pleurae do not correspond with the axial rings, and this is particularly apparent in the first 3–4 segments ; all the pleurae die out shortly before reaching the margin, which is slightly arched inwards to the sharp edge on which it joins the abruptly incurved narrow doublure, which, however, widens behind at the elongated tip of the pygidium. There is another nearly complete thorax (with 10 segments preserved)

attached to a pygidium in the Stellenbosch Museum (E 416) from Osplaats in the Hex River Valley, which shows essentially the same characters, but has a more complete agreement in its tuberculation with Frech's figure.

In the South African Museum there is a complete individual (7192 S.A. Mus.) from Whupperthal, Clanwilliam, which seems identical, as far as the thorax and pygidium are concerned, with *H. perarmatus*, in all respects closely resembling Frech's figure. The head-shield has the front margin broken, but otherwise is nearly perfect. The glabella is scarcely urceolate, being of a suboblong shape ; the anterior end is rather abruptly truncated, with a slight median emargination ; the lateral angles of the frontal lobe are rounded, and it does not clearly project on each side. The lateral furrows are distinct, but the anterior ones which are situated at less than one-third the length of the glabella are weakest ; the second pair is strong, horizontal, and at half the length of the glabella, while the basal ones are oblique, long, and demarcate triangular basal lobes, each occupying more than one-third the basal width of the glabella. The meso-occipital furrow is gently arched forward in the middle, and the paraglabellar areas slightly excavate the sides of the basal lobes. The meso-occipital ring is too much broken to show if it possessed any tubercles, but there is a swelling on the pleuro-occipital ring at about half its length carrying one or two spines. The fixed cheeks are narrow, being only about one-third the width of the glabella at the eyes, which are situated opposite the 2nd lateral furrows of the glabella ; there is a weak, circumocular furrow on the swollen cheek. The free cheeks are rather steeply bent down ; the lateral margins are nearly straight ; the genal angles are rather sharply rounded and somewhat produced backwards. The facial sutures in front of the eyes slightly converge ; but behind the eyes their posterior branches run obliquely back to cut the lateral margin just in front of the genal angles. The whole surface of the head-shield is rather coarsely, but closely and uniformly granulated.

The thorax and pygidium are almost identical with the specimen above described (7194 S.A. Mus.), except in the distribution of the tubercles and spine-bases. Thus there is a lateral spine-base, or large tubercle, on the left side of the 1st, 2nd, 5th, and 6th axial rings of the thorax, but on the right side there is one on the 1st (?) and 3rd, and then again on the 6th, 7th, 11th, and 13th, while the 3rd, 4th, 5th, and 9th right pleurae possess one just outside the axial furrow, and then another further out on the 13th

only. But on the left side the pleurae are broken off, so we do not know their distribution. On the pygidium there is a lateral spine-base on the 1st, 2nd, and 3rd axial rings on the right side, and on the 4th and 9th on the left side; on the right pleural lobe there are no spine-bases or tubercles at all, but on the left lobe the 1st pleura has one at half its length, and the 4th pleura has two smaller ones respectively at one-fourth and three-fourths its length. The non-correspondence of the pleurae with the axial rings is noticeable, but the change in the rate of tapering of the axis is scarcely apparent, though the lateral emargination and concavity on the sides of the pleural lobes is nearly as marked as in the other specimen (7194 S.A. Mus.).

With regard to *H. horridus*, which Schwarz thought might be inseparable from *H. perarmatus*, but which Clarke * considered belonged to *H. Herscheli*, an examination of the original specimen in the Albany Museum leads me to conclude that Schwarz was right. But it does not seem possible to separate it satisfactorily from *H. agrestis*, for there is no essential or constant difference, even the rate of tapering of the axis and excavation of the margins of the pygidium showing variability.

The type specimen of Schwarz's species (1444 Alb. Mus.) came from Clanwilliam, as does the above described complete individual (7192 S.A. Mus.), and it consists of a pygidium with a few thoracic rings attached. Neither the figure nor the description which Schwarz gave are quite sufficient, and a few more details of its characters may therefore be given. Each axial ring of the thorax has a single lateral tubercle, or a pair of closely-set tubercles on one base, while each pleura has only one large tubercle set at about one-third its length. Thus the tuberculation of the thorax much resembles that of *H. perarmatus* Frech, as Schwarz remarks. The pygidium of *H. horridus* possesses 13 distinct rings on the axis with traces of 1 or 2 more behind, and the first 6 axial rings have a lateral tubercle on the right side forming a regular longitudinal series, but on the left side it is only the 1st and 3rd rings which bear a corresponding lateral tubercle; there is a median tubercle also on the 2nd, 3rd, 4th, 6th, 7th, 12th, and 13th rings. As Schwarz remarks, the pleurae do not quite correspond with the axial rings, and die out some little distance from the edge of the pygidium, while the 2nd, 3rd, and 6th pleurae on the right side have a pair of closely-set tubercles, but only the 4th pleura on the left side has a similar pair, the rest on this side being without tubercles, except the 1st one, which has a single tubercle at about two-thirds its length.

* Clarke, *op. cit.*, 1913, p. 96.

Dimensions :—

	(7194 S.A. Mus.)	(7192 S.A. Mus.)
Length of head-shield . .	..	+37·0 mm.
Width of ,, ...	..	70·0 ,,
Length of glabella . . .	..	26·5 ,,
Width ,, ,, at base . .	..	26·5 ,,
,, ,, ,, at front . .	..	21·5 ,,
Length of thorax . . .	..	62·0 ,,
,, ,, ,, (10 segments) .	58·0 mm.	..
Width of axis at front end . .	44·0 ,,	37·0 ,,
Width of thorax	c. 63·0 ,,	..
Length of pygidium . . .	c. 50·0 ,,	+45·0 ,,
Width ,, ,, at front .	c. 41·0 ,,	c. 38·0 ,,
,, ,, axis at front . .	26·0 ,,	23·5 ,,
Length of axis	35·5 ,,	c. 36·0 ,,

The lack of bilateral symmetry and the general irregularity in the distribution of the tubercles and spine-bases on the thorax and pygidium is a noticeable feature in all the forms here regarded as varieties of *H. Herscheli*, and for this reason the tuberculation must be regarded as of small specific or varietal value. Individuals, otherwise identical, differ considerably in this respect.

Homalonotus (*Burmeisteria*) *Herscheli* Murch. var. nov. *sodalis*.

(Pl. X, fig. 5.)

Cf. 1913. *Homalonotus Herscheli* Clarke, "Foss. devon. Parana," pl. iii, fig. 1, ? 2.

Head-shield transversely subparabolic, about twice as broad as long, gently convex from side to side, but not much bent down laterally. Glabella very slightly elevated, suboblong, as wide as long, narrowing a little anteriorly, the sides at first converging and then parallel, slightly concave; front end straight, abruptly truncated at right angles to axial furrows; lateral furrows nearly obsolete, the first pair nearly straight, obliquely directed backwards, situated at about one-fourth the length of the glabella, the second pair straight, nearly horizontal, situated at about half the length of the glabella, the basal pair longer, oblique, faintly marking off large, triangular, basal lobes. Paraglabellar areas large, nearly obsolete, not excavating sides of basal lobes. Cheeks with inner portion forming swollen boss

on which eyes are situated, at about level of second lateral furrows, and at less than half width of glabella from axial furrows; circum-basal furrow round eyes weak. Facial sutures with anterior branches rather rapidly convergent, nearly straight to front edge, then bending in sharply to unite as simple, nearly straight, transverse suture; posterior branches bending out behind eyes nearly at right angles in weak, sigmoidal curve, to cut lateral margin of genal angles in front of base of head-shield. Meso-occipital ring simple, smooth, without tubercles, extending outwards on each side to below eyes beyond base of glabella, the ends being marked by notches in posterior edge of head-shield; meso-occipital furrow strong, slightly arched forward in middle. Pleuro-occipital portion rounded, becoming swollen and wider laterally, and bearing group of 3 small spine-bases (of which the middle one is the largest) at about half its length; pleuro-occipital furrow weak, broad, dying out laterally. Genal angles broadly rounded. Marginal furrow quite obsolete. Preglabellar area flattened. nearly horizontal, large.

Dimensions (7199 S.A. Mus.):—

Length of head-shield	52·0 mm.
Width ,, ,, ...	*c.* 106·0 ,,
Length of glabella	37·5 ,,
Width ,, ,, at front . . .	28·0 ,,
,, ,, ,, at base . . .	35·5 ,,
Distance between eyes	53·0 ,,
,, ,, notches at sides of meso-occipital ring	48·5 ,,

Remarks.—There is one well-preserved head-shield in the South African Museum (7199 S.A. Mus.) on which this variety is based. It differs from *H. Herscheli* var. *rectisuturalis* by the different shape of the glabella, which is more truncate, and that there is no lateral overhang of the frontal lobe; the head-shield is also subparabolic, and the course of the facial sutures is slightly different. The new form *H. noticus* var. *africana* (described below) differs in the shape of the glabella and position of the lateral furrows on it as well as by the swelling of the lateral angles of the preglabellar area. Our specimen figured here is a good cast of the head, with the left side and whole middle-shield perfect; no rostral apiculus is seen, but probably a short one was present. The surface ornamentation is unknown. It is possible that this variety should be separated off as a distinct species.

Homalonotus (*Burmeisteria*) *quernus* Lake.

(Pl. X, fig. 1 ; Pl. IX, fig. 13 ?.)

1904. *Homalonotus quernus* Lake, Ann. S. Afr. Mus., vol. iv, pt. 4, No. 9, p. 216, pl. xxvii, fig. 1 (22 S.A. Mus.).

? 1904. *Homalonotus* sp. Lake, *ibid.*, p. 217, pl. xxvii, fig. 2 (23 S.A. Mus.).

1913. *Homalonotus quernus*, Clarke, "Foss. devon. Parana," p. 95.

This species was founded by Lake on an imperfect head-shield from an unknown locality, having a peculiar coarsely-tuberculated glabella, but the figure of the specimen did not show the three pairs of lateral furrows which are distinct on the left side, the lobation being quite clearly developed, nor was the anterior narrowing of the glabella indicated ; it should also be pointed out that there is a group of specially-large tubercles on each basal lobe, and a large prominent tubercle or spine-base on each side of the meso-occipital ring, situated close to the axial furrows. Several thoracic segments were associated with this head-shield, but somewhat out of their natural position. The length of the glabella in the type specimen (22 S.A. Mus.) is about 50 mm., and its basal width about 55 mm. ; so that it has a very short quadrate shape.

There is a well-preserved head-shield (In. 24101) in the British Museum, labelled simply "Cape of Good Hope," and named *H. Herscheli*, which is clearly identical with Lake's *H. quernus*, and it allows us to give a fuller definition of the species than Lake was able to do. This specimen shows that the head-shield has a transverse subparabolic rather than subtriangular shape, and is about twice as wide as long. The glabella is trapezoidal and not urceolate in shape, the sides converging anteriorly to about half its length, and then becoming subparallel to the abruptly-truncated, nearly-straight, anterior end. The lateral lobes are distinguishable, but the lateral furrows are very faintly impressed. Well-defined subcircular paraglabellar areas are present, but scarcely invade the basal lobes. The cheeks are much swollen, the inner part forming a prominent rounded boss which bears the eye, but the outer part is somewhat flattened and strongly arched down. The preglabellar area is flattened and smooth, but its front edge is broken. There are 5–6 tubercles on the meso-occipital ring, and the pleuro-occipital portion widens laterally to an obliquely-truncated outer end, swelling up near the genal angle into a large spine-base or tubercle. The occipital furrow is

strong, but the marginal furrow rather weak. The tuberculation of the glabella is much the same as in Lake's type specimen, the tubercles being few, of large but rather unequal size and irregularly distributed. The doublure is seen to be ornamented by short, minute, slit-like pits, elongated parallel to the edge and arranged in concentric lines, and the rostral shield is exposed below, though broken and imperfect, and bears a short, stout, subconical uncate apiculus. The fine ornamentation of the surface of the head-shield consists of a minute granulation with rather larger granules dotted about, as in *H. Herscheli*.

Dimensions :—

Length of head-shield . .	*c.* 38 mm.
Width ,, ,, . .	*c.* 62 ,,
Length of glabella . . .	26 ,,
Width of ,, at base . .	28 ,,
,, ,, ,, at front . .	19 ,,
Distance between eyes . .	38 ,,

It is probable that the large pygidium from Ezelfontein (23 Cape Mus.) figured by Lake (*op. cit.*, pl. xxvii, fig. 2) as *Homalonotus* sp., should be attributed to *H. quernus*, for it possesses the large subequal, coarse, and numerous, but irregularly-distributed tubercles on its surface, like the head-shield on which the species is founded. We may observe that it possesses a similar outline and a similar change of rate in the tapering of the axis as *H. agrestis* Schwarz, and the latter species may be regarded as closely allied to Lake's *H. quernus*. Schwarz * has previously expressed the opinion that this pygidium is much like his *H. agrestis*, if not identical with it, but the spine-bases are much larger, coarser, and more numerous.

There is a portion of a thorax in the Kimberley Museum (3292 Kimb. Mus.) from Ceres, which has a very broad, flat axis, showing on each ring a large, single, lateral tubercle, or pair of tubercles (with sometimes a small accessory tubercle outside) on each side, and a row of 6–9 smaller subequidistant ones over the middle portion, so that the whole ring is tuberculated. The axial furrows are shallow, but there is a marked constriction separating off the pleural lobes from the axis, and the lobes are strongly bent down and much narrower than the axis. Each pleura bears a single large, or one large and one small, tubercle or spine-base, just at its base, and the whole surface of the thorax is covered with small closely set scabrosities or elongated granules.

* Schwarz, *op. cit.*, 1906, p. 387.

From the fact that the meso-occipital ring of *H. quernus* is the only species which bears a considerable number of tubercles or spine-bases, we may probably refer this thorax to this species on the strength of the numerous tubercles on the axial rings. Perhaps the few thoracic segments figured by Salter * from the Gydo Pass (11280 Brit. Mus.) as belonging to *H. Herscheli*, may, for the same reason, be placed here, though Schwarz † attributed them to his species *H. horridus*.

Dimensions (3292 Kimb. Mus.) :—

Length of the 8 segments of thorax .	55 mm.
Width of thorax at front . .	*c.* 110 ,,
,, ,, axis at front . . .	*c.* 45 ,,

Homalonotus (*Burmeisteria ?*) *hippocampus*, Schwarz.

1906. *Homalonotus hippocampus* Schwarz, Rec. Albany Mus., vol. i, pt. 6, p. 388, pl. ix, figs. 5*a*, *b* (64 Alb. Mus.).

1907. *Homalonotus hippocampus* Reed, Geol. Mag., Dec. v, vol. iv, p. 36.

1913. *Homalonotus hippocampus* Clarke, "Foss. devon. Parana," p. 96.

1918. *Homalonotus* (*Burmeisteria*) *hippocampus* Reed, Geol. Mag., Dec. vi, vol. v, pp. 315, 324.

This species was based by Schwarz on a nearly-perfect head-shield from an unknown locality, and the description is fairly complete. Clarke (*op. cit.*), however, thought that it might represent a young *H. Herscheli*, and was doubtful of its specific value. It is worthy of notice that a head-shield from Brazil, which was figured by Clarke ‡ as probably the young of his new species *H. Derbyi*, bears a considerable resemblance to *H. hippocampus*.

The median ridge along the glabella described by Schwarz in the type specimen is peculiar, but on examining the specimen it seems that it may be due to crushing, and not be an original feature. The shape of the glabella, the practical absence or obsolescence of the lateral furrows on its surface, the straight, transverse, connecting suture in front, the presence of a pair of spine-bases close to the genal angles, and other features suggest that it is only a young individual or narrow form of *H. Herscheli* var. *rectisuturalis*. In the Ordovician trilobite, *Ogygia Buchi* Brongn. we have a narrow and a wide form,

* Salter, *op. cit.*, 1856, pl. xxiv, fig. 5.

† Schwarz, *op. cit.*, 1906, p. 384.

‡ Clarke, "Trilob. Grez de Ereré," Archiv Mus. Nac. Rio de Janeiro, vol. ix, 1890, p. 7, t. i, fig. 7.

the difference being regarded as sexual. Possibly the same explanation is applicable here.

Homalonotus (*Burmeisteria*) sp.

1856. *Homalonotus Herscheli* Salter (pars), Trans. Geol. Soc., ser. 2, vol. vii, pl. xxiv, fig. 3 (11278 Brit. Mus.), *non cet.*

An examination of the head-shield (11278 Brit. Mus.) from the Warm Bokkeveld, which Salter only indicated by a restored outline on his plate, and attributed to *H. Herscheli*, shows that it is better preserved than one would imagine, and that it is quite distinct from the typical *H. Herscheli.* Each of the basal lobes bears a spinose tubercle and there is also a submedian, more anteriorly-placed pair on the glabella, thus recalling their development in *H. subarmatus* Koch.* The urceolate shape of the glabella, lobation, and paraglabellar areas resemble *H. Herscheli*, but the minute ornamentation of the surface is coarser, and the granules are closer together and of equal size. Probably it is a distinct species, but we may hesitate to give such an imperfect specimen a new name. The regularity and distribution of the spine-bases on the glabella resemble to a great extent those in the members of the European subgenus *Burmeisterella* (e.g. *H. Champernounei* and *H. bifurcatus*†).

Homalonotus (*Digonus*) *noticus*, Clarke, var. nov. *africana.*

(Pl. X, fig. 4.)

? 1856. *Homalonotus Herscheli* Salter (pars), Trans. Geol. Soc., ser. 2, vol. vii, pl. xxiv, fig. 8 (11283 Brit. Mus.), *non cet.*

Head-shield short, broad, transversely semi-elliptical, with anterior margin slightly excavated; genal angles very broadly rounded; cheeks very slightly bent down. Glabella low, subconical, truncated abruptly in front, wider than long, broadest at base, narrowing anteriorly rather rapidly for about three-fourths its length, with lateral angles of frontal lobe somewhat swollen and slightly overhanging; lateral furrows very weak, nearly obsolete; anterior pair very short, situated at about one-fourth or one-fifth length of glabella from front end, slightly oblique; second pair horizontal and at about half length of glabella; basal pair gently curved back, obscurely marking off large basal lobes. Preglabellar area wide, flattened, somewhat bent up,

* Koch, Abh. k. preuss. geol. Landesanst., vol. iv, pt. 2, 1883, p. 18 [90], t. i, figs. 8, 9; Frech, Leth. Geogn., Palaeoz., vol. i, pt. 2, p. 218, text-fig.

† Reed, Geol. Mag., Dec. vi, vol. v, 1918, p. 325.

slightly depressed in centre with weakly excavated margin and swollen lateral angles. Cheeks strongly swollen, forming elevated bosses bearing small prominent eyes situated in front of second lateral furrows. and less than half width of glabella from its sides. Paraglabellar areas obsolete. Facial sutures with anterior branches short, strongly convergent to front edge, then bending in suddenly to unite in short, straight, transverse suture; posterior branches gently sigmoidal. Rostral apiculus very short, broad, triangular, projecting in front. Occipital segment simple, smooth, without spines or tubercles; occipital furrow strong. Marginal furrow obsolete. Surface of head-shield coarsely granulated.

Dimensions (247 Cape Univ.) :—

Length of head-shield . .	19·0 mm.
Width ,, ,, . .	29·0 ,,
Length of glabella . .	12·0 ,,
Width ,, ,, at base .	14·0 ,,

Remarks.—There is only one good specimen (247 Cape Univ.) of this trilobite, and it consists of a nearly complete head-shield from Touws River Road. It may be regarded as a variety of *H. noticus* Clarke * from the Devonian of Brazil on account of its proportions, the truncate and emarginate anterior margin, the characters of the glabella, the course of the facial sutures, the well-rounded genal angles, and especially in the absence of tubercles and spine-bases. But our specimen has a coarsely-granulated instead of smooth surface. *H. Clarkei* Kozl.† also resembles it in the short glabella, swollen lateral angles of the preglabellar area, and coarse granulation. A distorted head-shield (438 Pret. Mus.) in the Pretoria Museum from Koudeveld Berg may perhaps be referred to our variety, and certain broad non-tuberculated pygidia, such as the one figured by Salter (*op. cit.*, fig. 8) (11283 Brit. Mus.), and one (3851 S.A. Mus.) in the South African Museum, may perhaps belong to it, as they much resemble *H. noticus*.

It is probable that this species and variety belong to the subgenus *Digonus* ‡ rather than to *Burmeisteria*, on account of the truncate or excavated anterior margin and absence of tubercles and spines.

Homalonotus (*Digonus*) *fontinalis* sp. nov.

(Pl. X, fig. 6.)

Head-shield subparabolic, with truncate anterior edge, excavated

* Clarke, *op. cit.*, 1913, p. 89, pls. i and ii.

† Kozlowski, *op. cit.*, 1923, p. 24, pl. i, figs. 12–15.

‡ Reed, Geol. Mag., Dec. vi, vol. v, 1918, pp. 317, 324.

in the middle; posterior margin nearly straight. Glabella large, oblong, semicylindrical, of nearly uniform width, fully one-third the width of head-shield and five-sixths its length, with straight subparallel sides, and truncate anterior end; three pairs of short, oblique, subparallel lateral furrows present, nearly equidistant, the anterior pair at about one-third the length of glabella from front end. Occipital ring simple, rounded, with pleuro-occipital portions widening somewhat to genal angles; occipital furrow strong, narrow, of uniform depth, continuous, straight, with meso-occipital portion slightly arched forward in middle. Preglabellar border narrow, rounded, with anterior edge slightly excavated in middle between swollen, projecting, lateral angles. Fixed cheeks gently convex, somewhat swollen in middle; free cheeks strongly arched down. Genal angles bluntly pointed at about 75° ? Facial sutures with posterior branches arched back to cut margin at genal angles. Eyes small, elevated, situated opposite 2nd lateral furrows of glabella, and at about half its width from axial furrows. Surface of head-shield covered with rather coarse, widely-separated, rounded granules.

Thorax of 13 segments. Axis wide, gently convex, semicylindrical. Axial furrows distinct. Pleural lobes gently arched down at about two-thirds the width of axis; pleurae slightly convex, with strong oblique pleural furrow. Ornamentation same as head-shield.

Pygidium parabolic, strongly convex from side to side, and less so from back to front, nearly as wide as long. Axis convex, conical, bluntly pointed, not reaching posterior margin entirely circumscribed by furrows; completely annulated to tip with about 15 narrow, simple, coarsely-granulated rings. Postaxial piece simple, narrow, gently convex, transverse, coarsely granulated, connecting pleural lobes behind.

Pleural lobes composed of 14–15 sharply-raised, distinct, narrow pleurae reaching margin of pygidium, and each bearing a single row of large granules.

Dimensions:—

Length of whole trilobite . .	*c.* 15·0 mm.
,, ,, head . . .	5·0 ,,
Width ,, ,, . . .	*c.* 9·5 ,,
Length ,, pygidium . .	*c.* 4·0 ,,

Remarks.—There is only one small complete individual representing this interesting species, and it is perfect, except for the genal angles

and part of the thorax. It was collected by me at Ezelfontein, near Ceres, and is undoubtedly distinct from all the other Bokkeveld species of *Homalonotus.* The pygidium is rather like that of *H. vanuxemi* Hall.* The anterior excavated median edge of the head-shield and swollen lateral angles of the preglabellar area resemble *H. Clarkei* Kozl.,† but the glabella is much longer and narrower, and the whole head less transverse. *H. noticus* has a much larger preglabellar area and a smooth surface.

Homalonotus sp.

There is a well-preserved, large, rostral shield, of a species of *Homalonotus* (264*a, b*) from Keurbosch, Hex River district, in the collection of the University of Cape Town, the specific reference of which is doubtful. It is trapezoidal in shape, the two straight, or nearly straight narrowly rounded anterior edges meeting at an angle of about 110° ; the longer posterior sides being inclined at an angle of about 75°, but the actual posterior angle is broken off. The general surface of the rostral shield is flat, but there is a slight concavity anteriorly on each side of a very short, low, broad, rounded median ridge, which is an almost imperceptible elevation, but rises up suddenly into the short, broad, low, rounded, subconical, blunt apiculus, which is submarginal and situated immediately behind the median anterior angle of the rostral shield. There are fine granules scattered over the whole flat surface, replaced by larger rounded granules or small tubercles on the rounded anterior edges and on the apiculus.

The absence of a median longitudinal ridge and the general flatness of the whole rostral shield are features which somewhat resemble that of *H. noticus*,‡ but our specimen is broader and the apiculus is more marginal.

Dimensions (264 *a, b* Cape Univ.): Length, *c.* 31 mm.; width (max.), 28 mm.

From the same locality and in the same matrix and condition there is also a well-preserved hypostome of a *Homalonotus* in the collection of the Cape University (297), which probably belongs to the same

* Hall, Palaeont. New York, vol. iii, 1859, p. 352, pl. lxxiii, figs. 9–11 ; *ibid.*, vol. vii, 1888, p. 11, pl. v B, figs. 1, 2 ; Williams and Breger, *op. cit.*, 1916, p. 286, pl. xxii, figs. 10, 12, 13, 15, 21.

† Kozlowski, *op. cit.*, 1923, p. 24, pl. i, figs. 12, 13.

‡ Clarke, *op. cit.*, 1913, p. 89, pl. ii, figs. 1, 8 ; R. and E. Richter, Centralbl. f. Miner., etc., Jahrg. 1917, No. 5, pp. 114–120, text-figs. 1–3.

species. It is subquadrate in form with a nearly straight anterior edge and flattened broad expanded alae, the shape of which is not quite clear, as their margins are broken. Behind the alae the lateral edges of the hypostome describe a gently-concave curve to the rounded posterior lateral angles, which project back slightly as rounded lobes. The posterior margin of the hypostome between them is emarginate, forming a broad, shallow, concave curve. The body is suboval and moderately convex, rounded anteriorly, but truncate behind. There is a pair of oblique, macular ridges at three-fourths its length from the front end, and there is an irregular group of 4–5 tubercles in the middle line at about one-fourth its length from the front end. The furrow marking off the body from the alae and from the flattened anterior border connecting the alae is shallow and weak, but on each side of the body and behind it the furrow limiting is better defined, but is broader behind than at the sides. The lateral borders are somewhat elevated, but the posterior edge is more swollen and rounded between the lobes, which are flattened. The granules, which are scattered over the surface, are not all of one size, and are irregularly and sparsely distributed. The general characters of this hypostome are like those of *H. Dekayi* (Green),* a species which Kozlowski † figures from the Devonian of Bolivia.

Dimensions: Length, 17 mm.; width across alae, *c.* 28 mm.; width at posterior end, 16 mm.

Acidaspis Atherstonei sp. nov.

(Pl. VII, figs. 7, 7*a*, *b*.)

Thorax flattened, composed of 11–12 segments, with horizontally extended pleural lobes. Axis broad, occupying more than the middle third of thorax, gently convex, cylindrical, densely and finely tuberculated. Pleurae straight, horizontal, of uniform width to base of free spine (?), each pleura composed of a narrow, rounded, anterior band, extending three-fourths its length, and of a broader, more elevated, and convex posterior band, swelling out rather suddenly into a rounded, subterminal enlargement before bending down as a free spine; anterior band ornamented with a single row of a few large tubercles; posterior band with 2–3 irregular rows of smaller tubercles clustered rather closely together at the subterminal swelling. Pygidium small, flattened, semicircular; axis broad, short, conical, composed of 4–5

* Prosser and Kindle, Maryland Geol. Surv., 1913, Devonian, p. 328, pl. xliii, fig. 3.

† Kozlowski, *op. cit.*, 1923, p. 20, pl. i, figs. 1–10.

rings. Lateral lobes bearing 3 rounded, elevated, tuberculated, radiating pleurae on each side, widely separated by deep furrows. [? Margin of pygidium with corresponding free projecting spines.]

Dimensions :—

Length of thorax . . .	*c.* 35 mm.
Width ,, ,, at front .	*c.* 30 ,,
,, ,, axis at front . .	*c.* 11 ,,
Length of pygidium . .	*c.* 7 ,,
Width ,, ,, . .	*c.* 14 ,,

Remarks.—There are three specimens (In. 24103, 24104) in the British Museum, one of which (24103) consists of an impression and the natural cast (24103*a*), and the other of an impression only, all being portions of the thorax and pygidium of a species of *Acidaspis*, from Keurbooms River, Plettenberg Bay. The thorax is well preserved, but the ends of the pleurae are incompletely known, being broken off short or buried in matrix, and the pygidium is imperfect. But we may compare this species with *A. aracana* Steinmann,* from the Devonian of the Andes, and also with *A. tuberculata* Conr. var. *chacaltayana* Kozl.,† from Bolivia, with which the *Acidaspis* sp. figured by Salfeld ‡ from the same country may be identical.

Acidaspis capensis sp. nov.

(Pl. XI, figs. 6, 7.)

Head-shield unknown. Thorax with broad, cylindrical axis very slowly tapering, about one-third the total width; pleural lobes horizontal and flattened for about half their width as far out as fulcrum, then sharply arched down as free pleural spines. Axial rings convex, rounded, with slight lateral swellings. Pleurae somewhat flattened, straight, and horizontal to fulcrum, divided by sub-median, straight, horizontal furrow parallel to pleural edges into a narrower anterior rounded band and a broader, more swollen posterior band; fulcrum rounded; extra-fulcral portion unfurrowed, bent down and backwards, and produced into free, sub-cylindrical, rounded spine. Surface of axis and pleurae coarsely tuberculated, the anterior

* Steinmann, Neues Jahrb. f. Miner. Geol., Beil. Bd. 34, 1912, p. 206, t. xi, figs. 1, 2.

† Kozlowski, *op. cit.*, 1923, p. 58, pl. v, figs. 13, 14.

‡ Salfeld, " Devon. Verstein. Bolivien " (App. I, Hauthal, Reisen in Bolivien), Wissensch. Veroff. Gesell. Leipzig, 1911, p. 208, t. i, fig. 5.

pleural band bearing a single row of large, contiguous tubercles. Pygidium (imperfectly known), very small, short, semicircular, of 2–4 segments; margin rounded, tuberculated; axis prominent, subcylindrical, of 3 or 4 rings; pleural lobes with 2–3 rounded pleural ridges. Surface coarsely tuberculated like thorax.

Dimensions (116*a*, *b* Cape Univ.):—

Length of thorax (11 segments)	15·5 mm.
Width to fulcrum . . .	*c.* 14·0 ,,
,, of axis . . .	6·0 ,,
Length of pygidium . .	3·5 ,,

Remarks.—There is only one impression (116*a*) and cast (116*b*) of the thorax and pygidium of this species, and the specimens which come from Stettyn, Worcester district, are in the collection of the University of Cape Town. Only a few of the anterior pleural spines are preserved, and the pygidium is imperfect, but its margin seems to be entire, though the marginal tubercles may have been spinose.

It is quite distinct from *A. Atherstonei* and its allies.

List of Fossils from the Bokkeveld Beds.

Zaphrentis ? zebra Schwarz.
,, ? sp.
Striatopora ? sp.
Placocystis africanus sp. nov.
Codaster aff. *pyramidatus* Shumard.
Ophiocrinus Stangeri Salter.
Crinoid stems.
Echinasterella ? sp.
Aspidosoma ? sp.
Fenestella sp.
Monotrypa ? sp.
Lingula Keideli Clarke.
,, *lepta* Clarke.
,, *scalprum* Clarke.
,, (*Glossina*) sp.
Orbiculoidea (*Roemerella*) cf. *collis* Clarke.
,, ,, *Baini* (Sharpe).
,, ? *aberrans* sp. nov.
Orthis (*Dalmanella*) *satelles* sp. nov.
Stropheodonta Arcei Ulrich.
,, cf. *Katzeri* Knod.

Stropheodonta (*Leptostrophia*) *concinna* (Morris and Sharpe).
Schuchertella Sulivani (Morris and Sharpe).
,, *? Baini* (Sharpe).
Chonetes falklandicus Morris and Sharpe.
,, *Rücki* Ulrich, var. nov. *medialis.*
,, *Stübeli* Ulrich.
,, cf. *Hallei* Clarke.
,, aff. *arcuata* Hall.
,, sp.
Spirifer antarcticus Morris and Sharpe.
,, ,, var. nov. *gamkaensis.*
,, ,, var. *kayseriana* Clarke.
,, *Ceres* Reed.
,, ,, var. *Iheringi* Kayser.
,, *euelpis* sp. nov.
Meristella cf. *Riskowski* Ulrich.
Cryptonella Baini (Sharpe).
Centronella cf. *Derbyana* (Hartt).
Leptocoelia flabellites (Conr.).
Coelospira ? conjungens sp. nov.
Vitulina pustulosa Hall ?
Ambocoelia pseudo-umbonata Kozlowski.
Rensselaeria montaguensis Reed.
,, *relicta* Schwarz.
,, *rotunda* Reed.
Trigeria ? gydoensis sp. nov.
Scaphiocoelia africana Reed.
,, ,, *var. elizabethae* Reed.
Derbyina hottentot (Schwarz).
,, *simplex* (Schwarz).
,, *variegata* (Reed).
,, *whitiorum* Clarke, var. nov. *africana.*
Rhynchonella (*Clarkeia*) *Bodenbenderi* (Kayser).
Retzia ? Thomasi sp. nov.
Nuculites abbreviatus (Sharpe).
,, *africanus* (Sharpe).
,, cf. *Beneckei* Ulrich, var.
,, *capensis* Reed.
,, *obtusus* Reed.
,, *oblongatus* Conr.
,, *martialis* Reed.

Nuculites pacatus Reed.
,, *Sharpei* Reed.
,, ,, var. nov. *remota.*
,, (*Ditichia*) *colonicus* Reed.
Palaeoneilo antiqua (Sharpe).
,, *arcuata* Schwarz.
,, *rudis* (Sharpe).
,, *Orbignyi* Clarke.
,, ,, ,, var. nov. *tenuilineata.*
,, cf. *sancti-crucis* Clarke.
,, *subantiqua* Reed.
,, *vindicata* sp. nov.
Ctenodonta Grahami Reed.
,, *Stowi* sp. nov.
,, ? *nigella* (Reed).
Nuculana inornata (Sharpe).
,, *viator* Reed.
,, ? *agrestis* Reed.
Modiomorpha hexensis sp. nov.
,, *lunulata* (Schwarz).
,, *montaguensis* sp. nov.
,, *nigra* (Reed).
,, cf. *austronotica* Clarke.
,, cf. *scaphula* Clarke.
,, (*Modiella ?*) sp.
Janeia Baini (Sharpe).
,, *braziliensis* Clarke.
,, *bokkeveldensis* (Reed).
,, ,, var. *acer* (Reed).
Grammysia (*Grammysioidea*) *corrugata* (Sharpe).
,, ,, *fontinalis* (Reed).
,, ,, *montana* Reed.
,, ,, *campestris* (Reed).
,, ,, *scaphuloides* sp. nov.
Goniophora gydoensis sp. nov.
,, ? sp.
Sanguinolites albanus Reed.
Sphenotus ? cf. *Gorceixi* Clarke.
Sphenotomorpha Bodenbenderi (Clarke) var. nov. *capensis.*
Toechomya ? rudis (Sharpe).
Buchiola subpalmata Reed.

Buchiola sp.
Cardiola sp.
Praecardium bokkeveldense Reed.
Myalina brevicardinalis sp. nov.
Actinopteria Eschwegii Clarke.
Pterinopecten ? sp.
Hyolithes subaequalis (Salter).
,, *D'Orbignyi* Kozlowski var. nov. *capensis*.
Conularia africana Sharpe.
,, ,, var. nov. *albertensis*.
,, *Baini* Ulrich.
,, *gamkaensis* sp. nov.
,, *ulrichana* Clarke.
,, *quichua* Steinm. and Dod.
Diaphorostoma Baini (Sharpe).
,, *?* sp.
Platyceras bokkeveldense sp. nov.
Loxonema capense Reed.
,, *zwartbergense* sp. nov.
,, cf. *gregaria* Knod.
Palaeoscurria Sharpei sp. nov.
Metoptoma capense Reed.
Pleurotomaria aff. *Kayseri* Ulrich.
Bellerophon (*Plectonotus*) *fraternus* Reed.
,, ,, cf. *Dereimsi* (Knod).
,, ,, cf. *laticarinatus* (Knod).
,, ,, *quadrilobatus* Salter.
,, ,, sp.
,, (*Patellostium*) *africanoides* sp. nov.
,, (*Tropidodiscus*) cf. *globosus* Knod.
,, cf. *morganianus* Hartt and Rathbun.
Orthoceras bokkeveldense Reed.
,, *gamkaense* Reed.
,, (*Spyroceras ?*) *rex* Schwarz.
Tentaculites Baini Reed.
,, *crotalinus* Salter.
,, *desuetus* sp. nov.
Serpulites sica Salter.
Proetus malacus Lake.
,, *hexensis* sp. nov.
Cyphaspis Dereimsi Kozlowski.

Dalmanites (*Anchiopella*) *africanus* Salter (sens. restr.).
,, ,, *cristagalli* (Woodw.).
,, ,, *arbuteus* Lake (emend.).
,, ,, *Baini* sp. nov.
,, (*Corycephalus ?*) *capensis* sp. nov.
,, (*Hausmannia*) *Dunni* sp. nov.
,, ,, *lunatus* Lake.
,, ,, sp.
,, (*Proboloides*) *ensifer* sp. nov.
,, (*Acastella ?*) *pseudoconvexus* sp. nov.
,, (*Cryphaeus*) *caffer* Salter (emend.).
,, ,, ,, var. nov. *albana*.
,, ,, ,, var.
,, ,, cf. *Pentlandi* Salter.
,, ,, cf. *australis* Clarke.
,, ,, ?, cf. *rostratus* Kozlowski.
,, ,, ?, *Ceres* Schwarz.
Phacops (*Calmonia*) *ocellus* Lake.
,, ,, *callitris* Schwarz.
,, ,, *impressus* Lake.
,, ,, ,, var. nov. *vicina*.
,, ,, *Lakei* sp. nov.
,, ,, ?, *pupillus* Lake.
,, (*Pennaia*) *Gydowi* Schwarz.
,, ,, *africanoides* (=*africana* Shand).
,, (*Phacopina*) *hiemalis* sp. nov.
,, (*Bouleia ?*) *Sharpei* sp. nov.
Typhloniscus Baini Salter.
Homalonotus (*Burmeisteria*) *Herscheli* (Murchison) (emend.).
,, ,, ,, var. nov. *bituberculata*.
,, ,, ,, var. *colossus* Lake.
,, ,, ,, var. nov. *fusiformis*.
,, ,, ,, var. nov. *Grahami*.
,, ,, ,, var. *perarmata* Frech.
,, ,, ,, var. nov. *rectisuturalis*.
,, ,, ,, var. nov. *sodalis*.
,, ,, *quernus* Lake.
,, ,, *hippocampus* Schwarz.
,, (*Digonus*) *noticus* Clarke var. nov. *africana*.
,, ,, *fontinalis* sp. nov.
,, sp. ind.

Acidaspis Atherstonei sp. nov.
,, *capensis* sp. nov.

General Characters and Relations of the Fauna.

The author in 1907 * gave a general account of the fauna of the Bokkeveld Beds and of its relations to those in the Devonian rocks of various parts of South America, and since then Clarke † has reviewed all the evidence in the light of further work. Kozlowski ‡ has also dealt with the subject still more recently. The general conclusion as to the close similarity of the fossils in these widely-separated areas has been maintained, but we have now additional evidence from South Africa to be brought forward in its support. The differences between this austral Devonian fauna and the corresponding boreal faunas of North America, and especially of Europe, are strongly marked. There can be but little doubt as to the age and correlation of the Bokkeveld Beds as a whole. The continental mass around which the southern Devonian shore-faunas flourished has been termed by Clarke § "Falklandia," "the parent land-asylum out of which, in post-carboniferous time, Western Gondwana and Antarctis were carved."

The following is a list of Bokkeveld fossils which occur in the corresponding beds in South America or on the Falkland Islands :—

Lingula Keideli.
,, *lepta.*
,, *scalprum.*
Orbiculoidea Baini.
Stropheodonta Arcei.
,, *concinna.*
Schuchertella Sulivani.
Chonetes falklandicus.
,, *Stübeli.*
Spirifer antarcticus (and vars.).
,, *Ceres.*
,, ,, var. *Iheringi.*
Leptocoelia flabellites.

* Reed, Geol. Mag., Dec. v, vol. iv, 1907, pp. 165–171, 222–232.

† Clarke, "Foss. devon. Parana," Mon. Serv. Geol. Miner. Brasil, vol. i, 1913, pp. 1–83, 326–351.

‡ Kozlowski, "Faune dev. Bolivie," Ann. de Paléont., vol. xii, 1923, pp. 5–19 and 102–109.

§ Clarke, Proc. Nat. Acad. Sc. U.S.A., vol. v, 1919, p. 102.

Cryptonella Baini.
? *Vitulina pustulosa.*
Ambocoelia pseudo-umbonata.
Rhynchonella Bodenbenderi.
Nuculites capensis.
,, *obtusus.*
,, *oblongatus.*
,, *pacatus.*
,, *Sharpei.*
? *Palaeoneilo sancti-crucis.*
,, *orbignyi.*
Nuculana viator.
Janeia braziliensis.
,, *bokkeveldensis.*
Actinopteria Eschwegei.
Hyolithes subaequalis.
Conularia africana.
,, *Baini.*
,, *ulrichana.*
,, *Quichua.*
Orthoceras bokkeveldense.
Tentaculites crotalinus.
Serpulites sica.
Cyphaspis Dereimsi.
Dalmanites (*Anchiopella*) *africanus* (=*acacia*).
? *Phacops* (*Calmonia*) *ocellus.*
Homalonotus (*Burmeisteria*) *Herscheli.*

Of those Bokkeveld fossils which may only be compared with South American species because of the impossibility of exact identification which is generally due to the poor preservation or imperfection of the available material, the following is a list :—

Codaster cf. *pyramidatus.*
Orbiculoidea cf. *collis.*
Stropheodonta cf. *Katzeri.*
Chonetes cf. *Hallei.*
Meristella cf. *Riskowski.*
Centronella cf. *derbyana.*
Modiomorpha cf. *scaphula.*
Nuculites cf. *Beneckei.*
Sphenotus cf. *Gorceixi.*

Loxonema cf. *gregaria.*
Bellerophon cf. *Dereimsi.*
,, cf. *laticarinatus.*
,, (*Tropidodiscus*) cf. *globosus.*
,, cf. *morganianus.*
Dalmanites (*Cryphaeus*) cf. *australis.*
,, ,, cf. *rostratus.*
,, ,, cf. *Pentlandi.*

The following Bokkeveld fossils may be recognised as constituting definite varieties of South American species :—

Chonetes Rücki Ulr. var. nov. *medialis.*
Derbyina whitiorum Clarke, var. nov. *africana.*
Sphenotomorpha Bodenbenderi Clarke var. nov. *capensis.*
Hyolithes D'Orbignyi Kozl. var. nov. *capensis.*
Homalonotus noticus Clarke, var. nov. *africana.*

Of allied species in the South African and South American Devonian faunas we have the following :-

Orthis satelles . . .	. aff. *O. Pradoi* Kozl.
Spirifer euelpis . . .	. aff. *Spirifer plano-convexus* Knod.
Rensselaeria montaguensis .	. aff. *R. falklandica* Clarke.
Scaphiocoelia africana .	. aff. *Sc. boliviensis* Whitf.
Derbyina variegata . .	. aff. *D. Smithi* (Derby).
Nuculites obtusus . .	. aff. *N. Branneri* Clarke.
Palaeoneilo antiqua ,, *subantiqua* ,, *arcuata* .	. aff. *P. sancti-crucis* Clarke.
,, *vindicata* . .	. aff. *P. elliptica* Kozl.
Ctenodonta Grahami . .	. aff. *Ct. musculosa* Knod.
,, *? nigella* . .	. aff. *Nucula Kayseri* Clarke.
Nuculana inornata . .	. aff. *N. viator* Reed (=*N. inornata* Clarke, *non* Sharpe).
,, *viator* . .	. aff. *Leda* sp. *a* Ulrich.
Modiomorpha hexensis .	. aff. *M. pimentana* (pars) Clarke.
,, *lunulata* .	. aff. *M. Helmreicheni* Clarke.
,, *montaguensis*	. aff. *M. pimentana* Clarke.
,, *nigra* . .	. aff. *Goniophora? abbreviata* Clarke.
,, (*Modiella ?*) sp.	. aff. *Modiomorpha* sp. (Clarke).
Janeia Baini . . .	. aff. *J. braziliensis* Clarke.

Grammysia corrugata ,, *scaphuloides*	aff. *Modiomorpha ? scaphula* Clarke.
,, *fontinalis*	aff. *Gr. Lundi* Clarke. *Gr. Gardneri* Clarke.
,, *montana*	aff. *Gr. Lundi* Clarke.
,, *campestris*	aff. *Gr. rara* Kozl.
Sanguinolites albanus	aff. *Leptodomus* sp. Kayser.
Diaphorostoma Baini	aff. *D. furmanianum* H. and B. *D. allardycei* Clarke.
Loxonema capense	aff. *L. glabrum* Kozl.
,, *zwartbergense*	aff. *L.* aff. *attenuatum* Hall (*fide* Knod).
Pleurotomaria aff. *Kayseri*	aff. *Pl. Kayseri* Ulrich.
Bellerophon (*Plectonotus*) *fraternus*	aff. *B. Salteri* Clarke.
Orthoceras bokkeveldense	aff. *O. Ulrichi* Kozl. *O. Steinmanni* Kozl.
,, *gamkaense*	aff. *O.* cf. *gamkaense* Reed (*fide* Clarke and Kozl.).
,, *rex*	aff. *O. san-bartolomense* Kozl.
Tentaculites desuetus	aff. *T. Stübeli* Clarke.
Dalmanites (*Anchiopella*) *Baini*	aff. *Ph. acacia* Schwarz.
,, (*Corycephalus*) *capensis*	aff. *D. Drevermanni* Thomas. *D. Boehmi* Knod.
,, (*Hausmannia*) *Dunni*	aff. *D. maecurua* Clarke. *D. Clarkei* Ulrich.
,, ,, *lunatus*	aff. *D. patacamayensis* Kozl.
,, (*Proboloides*) *ensifer*	aff. *D. paituna* Hartt and Rathb.
,, (*Cryphaeus*) *caffer*	aff. *Cr. australis* Clarke.
Phacops (*Calmonia*) *Lakei*	aff. *Ph.* (*Calm.*) *ocellus* Clarke (? Lake).
,, ,, *callitris*	aff. *Ph.* (*Calm.*) *signifer* Clarke.
,, ,, *impressus*	aff. *Ph.* (*Calm.*) *subseciva* Clarke.
,, (*Acastella ?*) *pseudoconvexus*	aff. *Ph.* ("*Ac.*") *convexus* Ulr.
,, (*Pennaia*) *Gydowi*	aff. *Ph.* (*Penn.*) *pauliana* Clarke.
,, (*Phacopina*) *hiemalis*	aff. *Ph.* (*Phac.*) *devonica* Ulr.
,, (*Bouleia*) *Sharpei*	aff. *Ph.* (*Boul.*) *Dagincourti* Ulr.
Acidaspis Atherstonei	aff. *A. aracana* Steinm.

Clarke * is of the opinion that there is an "evident closer affiliation in expression between the Falkland fauna with that of the Bokkeveld

* Clarke, *op. cit.*, 1913, pp. 329–332.

series than with the much nearer regions at the west," but the foregoing list hardly points that way, and the richness of the South African fauna more approaches that of the continent of South America.

As regards the stratigraphical succession and lithological characters of the beds, Clarke * has pointed out that just as in the Bokkeveld series there are shales with calcareous nodules near the base, so in the Falkland Islands and in the Ponta Grossa shales of Parana there are similar nodules, and he remarks that "their general distribution through the austral beds may indicate correlative sedimentary conditions." The general uniformity and absence of differentiation of the sedimentary and of the faunistic facies of the beds is a remarkable feature throughout the whole austral region, but local differences of minor importance are observable, and there are well-marked divisions into shales and sandstones in the South African succession. In Bolivia Kozlowski † has recognised several subdivisions of the Devonian, although the lithological composition of the whole series is fairly uniform, being likewise argillaceous or arenaceous shales, sandstones, and quartzites. This author correlates some of the South American Beds with the Middle or even Upper Devonian of North America, but he puts all the South African Bokkeveld Beds and the Devonian of the Falkland Isles with the Lower Devonian (Oriskany), and in South America he puts on the same general horizon the Icla Formation of Bolivia, the Parana, the Grès de Maecuru, and the Matto Grosso and Argentine beds.

Clarke (*op. cit.*, p. 7), after a wide study of the various collections from South America, the Falkland Islands, and South Africa, concludes that "the entire assemblage, inclusive of all the Devonian faunas thus far known from Brazil (with the exception of the sandstone fauna (Middle Devonian) and black shale fauna (Upper Devonian) of Ereré and vicinity) from all horizons in Bolivia, Argentina, the Falkland Islands, and Cape Colony (not including the Witteberg Beds), bears a special and distinctive impress which is characterised as austral in contrast to the boreal aspect of homotaxial faunas north of the equator. These distinctions consist in specific resemblances without identities; in parallel developments affording different resultants; in invasions of generic structures more or less clearly disturbing generic agreements, and in irregular outgrowth of species distinctions on generic foundations common both to the north and the south." He further states that the fauna is seen to be essentially a unit and biologically uniform, and that its intrinsic

* Clarke, *op. cit.*, 1913, pp. 328, 329. † Kozlowski, *op. cit.*, 1923, pp. 7–19.

characters indicate that it represents only the Early Devonian stages, the later stages of the Devonian being wholly absent.

Clarke (*op. cit.*, 1913, pp. 21–27) has specially emphasised the fundamental stamp and generic and specific differentials of the members of the austral fauna, particularly in the case of the trilobites (phacopids) and lamellibranchs (taxodonts). In his special remarks on the Bokkeveld Beds in relation to those of other areas in the austral province (Clarke, *op. cit.*, pp. 57–61), he comments on the doubtful basis of many of the species, and of the poor preservation of many of the specimens which make not only their specific definitions but also their supposed affinities to be of an unsatisfactory nature and questionable value. To some extent the new Bokkeveld material which the author has described in the preceding pages removes this reproach, and enables us with much greater assurance to estimate the relationships of the members of the fauna and of its characters as a whole.

With regard to the stratigraphical or local distribution of the fossils in the Bokkeveld Beds, we have only a comparatively few cases in which a careful collection has been made from the same horizon or bed at different localities, but so far as this evidence goes it indicates that a zonal distribution of the fauna is probably present, certain species being specially abundant on, or restricted to, certain horizons. Much further collecting and work of this kind are required before we can say that definite stratigraphical horizons can be recognised in the Bokkeveld series by means of their fossil contents.

Thus Dr. S. H. Haughton has recently collected a number of fossils from the First Sandstone east of Klein Straat Siding, and they comprise the following species :—

Leptocoelia flabellites Conr.
Spirifer antarcticus Morr. and Sh.
,, ,, var. *kayseriana* Clarke.
,, *Ceres* var. *Iheringi* Kayser.
Stropheodonta Arcei Ulr.
Derbyina whitiorum Clarke, var. *africana.*
Janeia brasiliensis Clarke.
Bellerophon (*Plectonotus*) sp.
Crinoid stems, etc.

The present author obtained the following fossils from the one small exposure of beds at a roadside cutting near Buffelskraal, north-east of De Doorns, in the Upper Hex River Valley; all of these species came from the same bed, a greenish, micaceous sandstone.

Placocystis africanus sp. nov.
Codaster aff. *pyramidatus* Shum.
Leptocoelia flabellites Conr.
Cryptonella Baini Morr. and Sh.
Derbyina whitiorum Clarke, var. *africana ?*
Retzia ? Thomasi sp. nov.
Stropheodonta Arcei Ulr.
Sphenotomorpha Bodenbenderi Clarke, var.
Modiomorpha hexensis sp. nov.
Tentaculites desuetus sp. nov.
Cyphaspis Dereimsi Kozl.
Dalmanites (*Cryphaeus*) *caffer* Salt.
,, ,, cf. *rostratus* Kozl.
,, (*Anchiopella*) sp.
Phacops (*Calmonia*) *Lakei* sp. nov.
Homalonotus (*Burmeisteria*) *Herscheli* (Murch.) ?

In the collection of the Cape University there are many specimens from a locality termed "Touw's River Road, Upper Hex River Valley," which are preserved in precisely the same rock and condition as those collected by me near Buffelskraal in this valley, and the reverse of one of the specimens of *Phacops Lakei* (138 Cape Univ.) was found by me at this place, so that it is practically certain that the locality as well as the horizon is identical. The following species have been recognised in the collection made by Messrs. A. R. E. Walker and F. C. Partridge in the Cape University :—

Chonetes Rücki var. *medialis* (207 Cape Univ.).
Phacops (*Calm.*) *Lakei* (138, 232, 257, 147 Cape Univ.).
,, (*Phacopina*) *hiemalis ?* (243 Cape Univ.).
,, (*Bouleia ?*) *Sharpei* (198 Cape Univ.).
Dalmanites (*Anch.*) *Baini* (181a Cape Univ.).
,, (*Coryc.*) *capensis* (216 Cape Univ.).
,, (*Hausm.*) sp. (202 Cape Univ.).
,, (*Cryph.*) *caffer* (175, 179, 169 Cape Univ.).
Homalonotus (*Burm.*) *Herscheli* var. *rectisuturalis* (251, 229, 180 Cape Univ.).
,, *noticus* var. *africana* (247 Cape Univ.).

As regards other localities the following lists of fossils can be given from my examination of the collections in various museums, but it cannot be maintained that only one horizon is represented at each

locality or that the specimens have all been obtained from precisely the same spot, for the local names have been frequently used with a wide significance.

HOTTENTOT'S KLOOF, CERES.

Striatopora ? sp. (H 67 Stell. Mus.).
Lingula Keideli (120 S.A. Mus.).
,, *scalprum* (H 67 Stell. Mus.).
,, (*Glossina*) sp. (121 S.A. Mus.).
Stropheodonta Arcei (81*f* S.A. Mus.).
Derbyina hottentot (2578 Alb. Mus.).
Nuculites abbreviatus (3847 S.A. Mus.).
,, *Sharpei* (3849 S.A. Mus.).
,, *colonicus* (3839, 3856 S.A. Mus.).
,, *capensis* (3827 S.A. Mus.).
Nuculana inornata (11340 Brit. Mus.) (3845, 3968, 3865 S.A. Mus.), (104 Alb. Mus.), (462 Pret. Mus.).
Palaeoneilo arcuata (3866 S.A. Mus., 2nd shale), (103 Alb. Mus.).
,, *rudis* (11341, 14847, 52051 Brit. Mus.), (3878, 3844, 3837, 800 S.A. Mus.), (83, 84, 85, 86 Alb. Mus.), (3844 S.A. Mus., 2nd shales).
,, *subantiqua* (3835, 3866 S.A. Mus.).
Modiomorpha cf. *austronotica* (122 S.A. Mus.).
Tentaculites desuetus (H 79 Stell. Mus.).
Pleurotomaria aff. *Kayseri* (70*f* S.A. Mus.).
Orthoceras gamkaense (3880 S.A. Mus.).
Dalmanites (*Cr.*) *caffer* (11286 Brit. Mus.), (3850 S.A. Mus.), (419 Pret. Mus.).
,, (*Cr.*) cf. *australis* (3850 S.A. Mus.), (11286 Brit. Mus.).
,, (*Anch.*) *africanus* (11297 Brit. Mus.).
Homalonotus Herscheli var. (3853 S.A. Mus.).

UITKOMST, CERES.

Stropheodonta concinna (466 Pret. Mus.).
Schuchertella Sulivani (2493 Alb. Mus.), (420 Pret. Mus.), (113, 365 S.A. Mus.), (157 S.A. Mus.).
Chonetes falklandicus ? (82*f* S.A. Mus.).
Leptocoelia flabellites (2493 Alb. Mus.), (415, 402 Pret. Mus.), (129 Kimb. Mus.), (1st Sand., 220 S.A. Mus.).
Spirifer antarcticus (215, 216, 217, 218, 219, 220 S.A. Mus.), (2601 Alb. Mus.).

Spirifer antarcticus var. *kayseriana* (404, 405 Pret. Mus.), (2601 Alb. Mus.), (Sedgw. Mus.).
,, *Ceres* (139 S.A. Mus.).
,, ,, var. *Iheringi* (S.A. Mus.).
Ambocoelia pseudo-umbonata (2493 Alb. Mus.), (130, 211 S.A. Mus.).
Spirifer euelpis (404 Pret. Mus.), (3820, 3821 S.A. Mus.).
Derbyina hottentot ? (129 Kimb. Mus.).
,, sp. (138 S.A. Mus.).
Vitulina pustulosa ? (220 S.A. Mus.).
Nuculana inornata (77*f* S.A. Mus.).
Palaeoneilo rudis (3822 S.A. Mus.).
? *Pterinopecten* sp. (82 S.A. Mus.).
Conularia sp. (138 S.A. Mus.).
Homalonotus Herscheli var. *colossus* (364 S.A. Mus.).
Proetus hexensis (3889 S.A. Mus.).

NEAR CERES VILLAGE, ALONG VALSCH RIVER.

Chonetes falklandicus (136 S.A. Mus.).

HAARTEBEESTE KRAAL, CERES.

Chonetes falklandicus (127 S.A. Mus.).

LAKEN VLEI, CERES.

Stropheodonta Arcei (408 Kimb. Mus.).
Schuchertella Sulivani (3371 S.A. Mus.).
Leptocoelia flabellites (3938, 3370, 3941 S.A. Mus.).
Cryptonella Baini (132, 134 S.A. Mus.), (459 Pret. Mus.).
Centronella cf. *derbyana* (132 S.A. Mus.).
Nuculites colonicus (3793 S.A. Mus.).
,, *Sharpei* (3788 S.A. Mus.).
Palaeoneilo Orbignyi (3791 S.A. Mus.).
Bellerophon cf. *laticarinatus* (3794, 3785 S.A. Mus.).
Tentaculites crotalinus (3794 S.A. Mus.), (132 S.A. Mus.).
Hyolithes subaequalis (3790 S.A. Mus.).
Dalm. (*Cr.*) *caffer* (3795 S.A. Mus.).
Homalonotus Herscheli var. *rectisuturalis ?* (3948 S.A. Mus.).

WOLVAART'S FARM, CERES.

Schuchertella Sulivani (212 S.A. Mus.).
Dalmanites (*Anch.*) *Baini* (26 S.A. Mus.).
,, (*Cr.*) *caffer* (34 S.A. Mus.).
Homalonotus Herscheli var. *Grahami* (203 S.A. Mus.).

Van Wyt's Farm, Ceres.

Nuculites Sharpei (68*f* S.A. Mus.).

Hottentot's Kraal, Ceres.

Orthis satelles (138*a*, 140a S.A. Mus.).
Chonetes sp. (3896, 3944, 3914 S.A. Mus.).
Stropheodonta cf. *Katzeri* (3903, 3904, 3923 S.A. Mus.).
,, *arcei ?* (3908 S.A. Mus.).
Coelospira conjungens (3895 S.A. Mus.).
Leptocoelia flabellites (3909 S.A. Mus.), (3804 S.A. Mus.), (3759 S.A. Mus.), (3923 S.A. Mus.), (3806 S.A. Mus.).
Spirifer antarcticus var. *kayseriana* (3806, 3804 S.A. Mus.).
Derbyina variegata (3889, 3875 S.A. Mus.), (400 Pret. Mus.).
,, *whitiorum* var. *africana* (3884, 3913, 3389 S.A. Mus.), (458 Pret. Mus.).
Cryptonella Baini (3928 S.A. Mus.).
Nuculites Sharpei (3929, 3835, 3832 S.A. Mus.).
Dalmanites (*Anchiop.*) *Baini* (3934 S.A. Mus.).

Witzenberg Valley, Ceres.

Chonetes Stübeli (126 S.A. Mus.).
Spirifer antarcticus (2600, 257, 40 Alb. Mus.), (140 S.A. Mus.).

Slangfontein, Ceres.

Spirifer ceres var. *Iheringi* (145 S.A. Mus.), (2597, 2598, 2599 Alb. Mus.).
Spiriferina euelpis ? (35 S.A. Mus.).
Ambocoelia pseudo-umbonata (130 S.A. Mus.).

Bavian's Kloof.

Centronella cf. *derbyana* (467 Pret. Mus.).

Zwar Moed, Ceres.

Lingula lepta (3763 S.A. Mus.).
Leptocoelia flabellites (3767 S.A. Mus.).
Nuculites Sharpei (3770 S.A. Mus.).
,, *oblongatus* (3777 S.A. Mus.).
Homalonotus Herscheli var. (3951 S.A. Mus.).

Two Miles N.E. of Ceres.

Stropheodonta cf. *Katzeri* (H 196 Stell. Mus.).

Ezelfontein, Ceres.

Orthis satelles (414 Pret. Mus.).
Schuchertella Sulivani (406 Kimb. Mus.), (417 Pret. Mus.), (2596 Alb. Mus.).
Derbyina whitiorum var. *africana* (48 Cape Univ.).
,, *variegata* (400 Pret. Mus.).
Leptocoelia flabellites (413 Pret. Mus.), (2596 Alb. Mus.).
Rhynchonella (*Clarkeia*) *Bodenbenderi* (Sedgw. Mus.).
Nuculites africanus (104 S.A. Mus.).
,, *abbreviatus* (2574 Alb. Mus.).
,, *oblongatus* (Sedgw. Mus.).
,, *martialis* (103 S.A. Mus.).
,, *pacatus.*
,, *Sharpei* (18, 19 S.A. Mus.), (418 Pret. Mus.).
,, *colonicus* (69 S.A. Mus.).
Nuculana viator (2576 Alb. Mus.).
Palaeoneilo subantiqua (85 S.A. Mus.), (158*a* S.A. Mus.), (2579 Alb. Mus.), (E 450, 451 Stell. Mus.).
,, *Orbignyi* (77 Cape Univ.).
,, *sancti-crucis* (3965 S.A. Mus.), (105 S.A. Mus.).
Grammysia fontinalis (183*a* S.A. Mus.).
,, *campestris* (102 S.A. Mus.).
,, *scaphuloides* (214 S.A. Mus.) (72 Cape Univ.).
Sphenotomorpha Bodenbenderi var. *capensis* (303 Cape Univ.).
Conularia ulrichana (E 455 Stell. Mus.).
Tentaculites crotalinus (E 452 Stell. Mus.).
Dalmanites (*Cr.*) *caffer* (18 S.A. Mus.).
Homalonotus Herscheli (414, 415 Kimb. Mus.), (29 S.A. Mus.).
,, ,, var. *rectisuturalis ?* (29 S.A. Mus.).
,, ,, var. *Grahami* (2554 S.A. Mus.).
,, ,, var. *bituberculata* (368 S.A. Mus.).
,, *fontinalis* (Sedgw. Mus.).
,, *quernus ?* (23 S.A. Mus.).

Gydo Pass, Ceres.

Orthis satelles (6721 S.A. Mus.).
Stropheodonta cf. *Katzeri* (128 S.A. Mus.).
Schuchertella Sulivani (5441, 5433, 5435, 5440 S.A. Mus.).
Chonetes cf. *Hallei* (6694 S.A. Mus.).
,, *falklandicus ?* (5426 S.A. Mus.).

Cryptonella Baini (135 S.A. Mus.).
Leptocoelia flabellites (11353 Brit. Mus.), (115, 116, 137, 153, 210, 5439 S.A. Mus.), (405 Kimb. Mus.), (506, 509 Pret. Mus.), (2587 Alb. Mus.).
Ambocoelia pseudo-umbonata (137 S.A. Mus.), (319 Univ. Cape), (128 Kimb. Mus.), (457 Pret. Mus.), (2591, 2594 Alb. Mus.).
Spirifer antarcticus var. *kayseriana* (401 Pret. Mus.).
,, *ceres* (S.A. Mus.).
Rensselaeria montaguensis (30 S.A. Mus.), (405 Kimb. Mus.).
Trigeria gydoensis (156 S.A. Mus.).
Derbyina simplex (2589 Alb. Mus.).
,, *hottentot ?* (153, 166 S.A. Mus.).
,, *whitiorum* var. *africana* (B 45500 Brit. Mus.).
Palaeoneilo arcuata (3960 S.A. Mus.), (Sedgw. Mus.).
,, *rudis* (S.A. Mus.).
Nuculites abbreviatus (11339 Brit. Mus.), (5432, 5423 S.A. Mus.), (411 Kimb. Mus.), (109 Alb. Mus.).
,, *africanus* (6702 S.A. Mus.), (11337, 11338 Brit. Mus.).
,, *obtusus* (121, 119, 130 Alb. Mus.).
,, *oblongatus* (6696 S.A. Mus.).
,, *pacatus* (108 Alb. Mus.).
,, *colonicus* (118 Alb. Mus.).
Ctenodonta Stowi (11353 Brit. Mus.).
Goniophora gydoensis (5436 S.A. Mus.).
Grammysia scaphuloides ? (77 Univ. Cape).
Janeia Baini (91 S.A. Mus.).
Actinopteria Eschwegii (14 S.A. Mus.).
Diaphorostoma Baini (106 Alb. Mus.), (11346, 11347 Brit. Mus.).
Palaeoscurria Sharpei (45501, 11332 Brit. Mus.).
Loxonema capense (164, 163 S.A. Mus.), (2543 Alb. Mus.).
Bellerophon cf. *Dereimsi* (213 S.A. Mus.).
Hyolithes subaequalis (8 S.A. Mus.).
Tentaculites Baini (181 S.A. Mus.).
Conularia quichua ? (72 S.A. Mus.).
Dalmanites (*Anch.*) *africanus* (33, 23 Alb. Mus.), (6695 S.A. Mus.), (11295 Brit. Mus.), (11287, 11296 ? Brit. Mus.).
,, (*Cr.*) *caffer* (2558 Alb. Mus.).
,, *? ceres* (27 Alb. Mus.).
Phacops (*Calm.*) *impressus* (24 Alb. Mus.), (11291 Brit. Mus.).
,, ,, *ocellus* (11284 Brit. Mus.).

Phacops (*Calm.*) *Lakei* (11289 Brit. Mus.).
,, (*Penn.*) *gydowi* (28, 26, 25 Alb. Mus.).
Typhloniscus Baini (37 S.A. Mus.), (11302 Brit. Mus.).
Homalonotus Herscheli (413 Kimb. Mus.), (45080 Brit. Mus.).
,, ,, var. *perarmata* (11279 Brit. Mus.).
,, ,, var. *rectisuturalis* (45075 Brit. Mus.).
,, *quernus ?* (11280 Brit. Mus.).
,, *noticus* var. *africana ?* (11283 Brit. Mus.).

Riet Vallei, E.N.E. of Ceres.

Grammysia (*Grammysioidea*) *scaphuloides* (192 S.A. Mus.).

Warm Bokkeveld, Ceres.

Crinoid stem-joints (Brit. Mus.).
Stropheodonta arcei (B 45502 Brit. Mus.), (11357 Brit. Mus.).
Stropheodonta concinna ? (131 S.A. Mus.).
Schuchertella Sulivani (11330 Brit. Mus.), (11331 Brit. Mus.), (89, 92, Alb. Mus.).
,, *? Baini* (11325 Brit. Mus.).
Chonetes falklandicus (11324 Brit. Mus.), (11326 Brit. Mus.).
,, *Hallei* (B 45502 Brit. Mus.).
Leptocoelia flabellites (89, 92 Alb. Mus.), (11325 Brit. Mus.).
Cryptonella Baini (11324 Brit. Mus.).
Spirifer antarcticus (119 S.A. Mus.), (11324 Brit. Mus.).
,, ,, var. *kayseriana* (11313 Brit. Mus.), (11318 Brit. Mus.), (11327 Brit. Mus.).
,, *ceres* (49 Alb. Mus.).
Rensselaeria relicta (93 Alb. Mus.).
Retzia ? Thomasi (? 131 S.A. Mus.).
Vitulina pustulosa ? (131 S.A. Mus.).
Nuculites obtusus (1485 Alb. Mus.).
Ctenodonta Grahami (81 Alb. Mus.).
Hyolithes subaequalis (11351 Brit. Mus.).
Serpulites sica (Brit. Mus.).
Bellerophon (*Plect.*) cf. *laticarinatus* (124, 126, 129 Alb. Mus.).
,, ,, *quadrilobatus* (11351 Brit. Mus.).
,, ,, *fraternus* (128 Alb. Mus.).
,, (*Trop.*) cf. *globosus* (Alb. Mus.).
Tentaculites crotalinus (11351 Brit. Mus.).
Homalonotus sp. (11278 Brit. Mus.).

Ceres.

Homalonotus quernus ? (3292 Kimb. Mus.).

Leo Hoek (?=Leeuwfontein, Warm Bokkeveld, Ceres).

Monotrypa ? sp. (11358 Brit. Mus.).
Nuculites ? ovatus (11342 Brit. Mus.).
Palaeoneilo antiqua (11336 Brit. Mus.), (14849 Brit. Mus.), (52056 Brit. Mus.).
,, *sancti-crucis ?* (I. 14848 Brit. Mus.).
Modiomorpha lunulata (135 Alb. Mus.).
Grammysia corrugata (11343, 14850 Brit. Mus.).
Toechomya ? rudis (11345 Brit. Mus.).
Janeia Baini (11344 Brit. Mus.).
Dalmanites (*Anch.*) *africanus* (11295 Brit. Mus.).
,, (*Cr.*) *caffer* (11290 Brit. Mus.).
Homalonotus Herscheli (11276, 11294, 11282, 52053 Brit. Mus.).
,, ,, var. (11277 Brit. Mus.).

Stettyn, near Worcester.

Acidaspis capensis (116 Cape Univ.).
Typhloniscus Baini (117, 120 Cape Univ.).

N.W. of Lady Grey, near Worcester.

Spirifer Ceres ? (143 S.A. Mus.).

Wolseley.

Homalonotus Herscheli (In. 22315, 22316 Brit. Mus.).

Gamka Poort.

Orbiculoidea Baini (159 S.A. Mus.).
Leptocoelia flabellites (146, 221, 12 S.A. Mus.), (403 Pret. Mus.), (Sedgw. Mus.).
Spirifer antarcticus var. *gamkaensis* (146 S.A. Mus.), (109 S.A. Mus.).
,, ,, vars. S.A. Mus.
Rensselaeria relicta (Sedgw. Mus.), (221 S.A. Mus.).
Derbyina variegata (456 Pret. Mus.).
Goniophora ? sp. (146 S.A. Mus.).
Nuculites obtusus (92, 97 S.A. Mus.).
,, *capensis* (93 S.A. Mus.).
Ctenodonta Stowi (95, 96 S.A. Mus.).

Bellerophon (*Plect.*) *quadrilobatus* (27 S.A. Mus.).
,, cf. *laticarinatus* (S.A. Mus.).
,, cf. *morganianus* (110 S.A. Mus.).
Conularia gamkaensis (75 S.A. Mus.), (2607 Alb. Mus.).
Diaphorostoma ? sp. (161, 162, 163 S.A. Mus.).
Orthoceras bokkeveldense (172, 173 S.A. Mus.), (Alb. Mus., 2564–7).
,, *gamkaense* (177, 178 S.A. Mus.).
Phacops (*Calm.*) *impressus* (43, 50, 44 S.A. Mus.), (Sedgw. Mus.), (2557, 2556 Alb. Mus.).
,, ,, ,, var. nov. *vicina* (418 Kimb. Mus.).
,, ,, *ocellus* (42, 58 S.A. Mus.).
Dalmanites (*Anch.*) *africanus* (67, 27, 68 S.A. Mus.).
,, ,, *arbuteus* (62, 64 S.A. Mus.).
,, ,, *Baini ?* (222 S.A. Mus.).
,, (*Hausm.*) *lunatus* (66 S.A. Mus.).
,, ,, *Dunni* (38, 3949 S.A. Mus.).
Phacops (*Calm. ?*) *pupillus* (59 S.A. Mus.).
Typhloniscus Baini (71 S.A. Mus.), (63, 41, 46 S.A. Mus.).
Homalonotus Herscheli var. *fusiformis* (21 S.A. Mus.).
Proetus malacus (45 S.A. Mus.), (Sedgw. Mus.).

Road between Montagu and Triangle.

Modiomorpha montaguensis (Stell. Mus.).
,, *nigra* (625 S.A. Mus.), (Stell. Mus.).
,, (*Modiella ?*) sp. (Stell. Mus.).

Roode Hoogbe Kloof, between Montagu and Triangle.

Loxonema cf. *gregarium* (5421 S.A. Mus.).

Montagu.

Ophiocrinus Stangeri (169 Pret. Mus.).
Derbyina sp. (2127 Alb. Mus.).
Rensselaeria montaguensis (1610, 1612 S.A. Mus.).
Spirifer antarcticus (12*a* S.A. Mus.), (134, 2128 Alb. Mus.), (1889 Alb. Mus.).
,, ,, var. *kayseriana* (134 Alb. Mus.).
? *Orthoceras bokkeveldense* (81 Cape Univ.).

North of Montagu.

Spirifer antarcticus var. *kayseriana* (147 S.A. Mus.).
Leptocoelia flabellites (147 S.A. Mus.), (134, 2128 Alb. Mus.).

Uitolugt, Montagu.

Lingula lepta (5415 S.A. Mus.), (169*a* S.A. Mus.).

Stinkfontein, near Triangle.

Spirifer antarcticus (154 S.A. Mus.), (north of Stinkfontein).
Leptocoelia flabellites (154 S.A. Mus.).
Centronella cf. *derbyana* (424 Pret. Mus.).
Rensselaeria rotunda (449 Pret. Mus.).
Palaeoneilo rudis (100 S.A. Mus.).

Two Hundred Yards from Triangle Station.

Orthis satelles (138*a*, 7203, 15 S.A. Mus.).
Dalm. (*Cr.*) *caffer* (138*a* S.A. Mus.).

S.E. of Triangle below Second Sandstone.

Spirifer Ceres (144, 149 S.A. Mus.).
Ctenodonta Stowi (133*a*, 7777 S.A. Mus.).

Third Sandstone, Tunnel Siding.

Lingula lepta (123 S.A. Mus.), (124 Sedgw. Mus.).

Shales above Third Sandstone, Tunnel Siding.

Sphenotus aff. *Gorceixi* (101 S.A. Mus.).

Three Miles S.E. of Triangle.

Spirifer antarcticus (160 S.A. Mus.).

Osplaats, De Doorns.

Orbiculoidea Baini (E 915 Stell. Mus.).
Spirifer antarcticus (E 3), (E 417 Stell. Mus.).
Janeia braziliensis (Stell. Mus.).
Dalmanites (*Cr.*) *caffer* (E 414, E 483 Stell. Mus.).
Phacops (*Penn.*) *africanoides* (E 416 Stell. Mus.).
Homalonotus Herscheli (E 415 Stell. Mus.).
,, ,, var. *perarmata* (E 416 Stell. Mus.).

Buffelskraal, De Doorns.

Dalmanites (*Cr.*) *caffer* (H 173 Stell. Mus.).
,, (*Cor.*) *capensis* (H 172 Stell. Mus.).

Black's Farm, De Doorns.

Meristella cf. *Riskowski* (H 64 Stell. Mus.).

De Doorns.

Ophiocrinus Stangeri (Sedgw. Mus.).
Chonetes Stübeli (Sedgw. Mus.).
Spirifer antarcticus var. *kayseriana* (1160 S.A. Mus.).
,, *Ceres* var. *Iheringi* (Sedgw. Mus.).
Leptocoelia flabellites (Sedgw. Mus.).
Palaeoneilo vindicata (Sedgw. Mus.).
Ctenodonta Stowi (Sedgw. Mus.).
Nuculites Sharpei (Sedgw. Mus.).
,, *pacatus* (Sedgw. Mus.).
Nuculana inornata (Sedgw. Mus.).
Dalmanites (*Cr.*) *caffer* (2463 S.A. Mus.).
Phacops (*Calm.*) *ocellus ?* (Sedgw. Mus.).
Homalonotus fontinalis (Sedgw. Mus.).
Proetus hexensis (H 176 Stell. Mus.).
Tentaculites crotalinus (Sedgw. Mus.).

Keurbosch, Hex River District.

Orbiculoidea ? aberrans (289 Cape Univ.).
Palaeoneilo Orbignyi var. *tenuilineata* (128 Cape Univ.).
Nuculites Sharpei var. *remota* (129 Cape Univ.).
Modiomorpha hexensis (280 Cape Univ.).
Sphenotomorpha cf. *Bodenbenderi* (303 Cape Univ.).
Tentaculites desuetus (135 Cape Univ.), (293, 291 Cape Univ.).
Homalonotus sp. (264*a*, 297 Cape Univ.).

First Sandstone, East of Klein Straat Siding.

Spirifer ceres var. *Iheringi* (1087, 1095, 1096, 1097 S.A. Mus.).
Nuculites abbreviatus (111 S.A. Mus.).
Janeia braziliensis (111 S.A. Mus.).

Klein Straat Station.

Dalmanites (*Cor.*) *capensis* (H 76 Stell. Mus.).
Janeia braziliensis (441 Pret. Mus.).

Kamanassie River, Oudtshoorn.

Janeia braziliensis (5419 S.A. Mus.).

Nooitgedacht, Oudtshoorn District.

Loxonema capense (S.A. Mus.).

Paarde Bout, Oudtshoorn District.

Loxonema capense (3287 Kimb. Mus.).

Uitgift, Caledon.

Leptocoelia flabellites (2588 Alb. Mus.).

Cockscomb Mountains.

Zaphrentis Zebra (1586 Alb. Mus.).
,, sp.
Leptocoelia flabellites (1588, 1589 Alb. Mus.).
Proetus malacus (Bl. Mus.) (35 Alb. Mus.).
Dalmanites (*Anch.*) *cristagalli* (Brit. Mus.), (5 Alb. Mus.).
,, ,, *africanus* (Bl. Mus.).
,, (*Cr.*) *caffer* (Bl. Mus.).
Phacops (*Penn.*) *gydowi* (Bl. Mus.).

Assegai Bosch, Roode Berg, Ladismith.

Rensselaeria relicta ? (149 S.A. Mus.).

Geelboschlaagte, Ladismith.

Orbiculoidea Baini (436 Pret. Mus.).
Leptocoelia flabellites (434, 436 Pret. Mus.), (S.A. Mus.).
Derbyina whitiorum var. *africana* (435, 436 Pret. Mus.).
Cryptonella Baini (511 Pret. Mus.), (Sedgw. Mus.).

Papenkuils fontein, Prins River, near Ladismith.

Stropheodonta Arcei (94, 97 Cape Univ.).

Uniondale.

Rensselaeria montaguensis (606 S.A. Mus.).

Prince Albert.

Buchiola subpalmata (593 Kimb. Mus.).
Conularia africana var. *albertensis* (2017 Kimb. Mus.).

Wolvereden, Prince Albert.

Dalmanites (*Anchiopella*) *africanus* (5420 S.A. Mus.).

Boschluis Kloof, Prince Albert.

Chonetes sp. (2582 Alb. Mus.), (496, 500, 487, 112, 118 S.A. Mus.).
Leptocoelia flabellites (2585 Alb. Mus.), (433 Pret. Mus.), (5*a*, 8*a*, 495 S.A. Mus.).
Spirifer antarcticus var. *kayseriana* (422 Pret. Mus.).
Derbyina whitiorum var. *africana* (427 Pret. Mus.).
,, *simplex* (8a S.A. Mus.).
Dalmanites (*Anchiop.*) *Baini* (433 S.A. Mus.).
Phacops (*Penn.*) *gydowi* (1167 S.A. Mus.).

Zwartberg Pass.

Orbiculoidea Baini (158 S.A. Mus.).
Palaeoneilo antiqua (S.A. Mus.).
,, *subantiqua ?* (S.A. Mus.).
Nuculites abbreviatus (1599 S.A. Mus.), (1618, 1616, 1615 S.A. Mus.).
,, *africanus* (1619, 1620 S.A. Mus.).
,, cf. *Beneckei* (1622 S.A. Mus.), (1181 S.A. Mus.), (Sedgw. Mus.).
,, *oblongatus* (1623 S.A. Mus.).
,, *obtusus* (1625, 1624, 622 S.A. Mus.), (Sedgw. Mus.).
,, *pacatus* (794 S.A. Mus.), (1626, 1627 S.A. Mus.), (1161*a* S.A. Mus.).
Ctenodonta ? nigella (3946 S.A. Mus.).
Nuculana viator (S.A. Mus.).
,, *agrestis* (S.A. Mus.).
Grammysia corrugata (S.A. Mus.).
,, *montana* (1805 S.A. Mus.).
Janeia bokkeveldensis (1607 S.A. Mus.).
,, ,, var. *acer* (625*c* S.A. Mus.).
Buchiola subpalmata (Sedgw. Mus.).
Cardiola sp. (Sedgw. Mus.).
Metoptoma capense (1178, 1179 S.A. Mus.).
Loxonema zwartbergense (624 S.A. Mus.).
Hyolithes d'Orbignyi var. nov. *capensis* (2018 Kimb. Mus.).

Koudeveld Berg, below First Sandstone.

Janeia braziliensis (S.A. Mus.).
Actinopteria Eschwegii (81 S.A. Mus.).
Conularia sp. (80 S.A. Mus.).
Typhloniscus Baini (458 S.A. Mus.).

Platyceras bokkeveldense (2442 S.A. Mus.).
Homalonotus noticus var. *africana* (438 and 431 Pret. Mus.).

Gouritz River.

Rensselaeria rotunda (605 S.A. Mus.).
Scaphiocoelia africana (607, 609, 1173 S.A. Mus.).

Steytlerville District.

Derbyina simplex var. (105 Port. Eliz. Mus.).

Bokke Rivier, 17 Miles from Touws River, on Road to Ceres.

Homalonotus Herscheli var. *rectisuturalis* (314 Cape Univ.).
,, ,, var. *colossus* (309, 310, and 317 Cape Univ.).

Langefontein.

Spirifer Ceres (Sedgw. Mus.).
,, ,, var. *Iheringi* (Sedgw. Mus.).

Cold Bokkeveld.

Leptocoelia flabellites (11319, 11320 Brit. Mus., etc.), (48, 42 Alb. Mus.).
Homalonotus Herscheli var. *perarmata* (7194 S.A. Mus.).
,, ,, var. *rectisuturalis* (7193 S.A. Mus.).

Winterhoek Mountains.

Dalmanites (*Cr.*) *caffer* var. *albana* (69 Alb. Mus.).
Phacops (*Phacopina*) *hiemalis* (In. 24100 Brit. Mus.).

Driefontein, Clanwilliam.

Orbiculoidea cf. *collis* (6716 S.A. Mus.).

Hoenderfontein, Clanwilliam.

Orbiculoidea Baini (2606 Alb. Mus.).
Diaphorostoma Baini (454 Pret. Mus.).
Dalmanites (*Ac.*) *pseudoconvexus* (7201 S.A. Mus.), (419 Kimb. Mus.).
,, (*Anch.*) *africanus* (453 Pret. Mus.).
,, (*Cr.*) *caffer* (2559, 2555, 74 Alb. Mus.).
Homalonotus Herscheli var. *bituberculata* (B 4 S.A. Mus.).

Whupperthal, Clanwilliam.

Orbiculoidea Baini (158 S.A. Mus.), (North of Wh.).
Bellerophon (*Plect.*) *fraternus* (1180 S.A. Mus.).
,, ,, cf. *laticarinatus* (107 S.A. Mus.), (road cutting north of Wh.).
,, ,, aff. *Reissi* (108 S.A. Mus.), (road cutting north of Wh.).
Homalonotus Herscheli var. *perarmata* (7192 S.A. Mus.).
Conularia africana (73, 74 S.A. Mus.).

Cedarberg, Clanwilliam.

Orbiculoidea Baini (11335 Brit. Mus.).
Nuculites africanus ? (11338 Brit. Mus.).
,, *obtusus* (130 Alb. Mus.).
,, *Sharpei* (131 Alb. Mus.).
Conularia africana (11348 Brit. Mus.).
,, *Baini* (116, 117 Alb. Mus.).
,, *ulrichana* (11349 Brit. Mus.).
Dalmanites (*Anch.*) *africanus* (I. 4047 Brit. Mus.).
Phacops (*Calm.*) *callitris* (29–34 Alb. Mus.), (In. 4955 Brit. Mus.).
,, ,, *ocellus* (14956, 14957 Brit. Mus.).
Homalonotus Herscheli (*lex*) (1, 13, 9 Alb. Mus.).
? ,, ,, var. *perarmata* (1444 Alb. Mus.).

Keurboom's River, Plettenberg Bay.

Crinoid stems (Durb. Mus.).
Leptocoelia flabellites (Durb. Mus.).
Spirifer antarcticus var. *kayseriana* (I. 858 Brit. Mus.).
Nuculites africanus (795 S.A. Mus.), (1830 Brit. Mus.).
Loxonema zwartbergense (G. 1711 Brit. Mus.).
Orthoceras (*Spyr. ?*) *rex* (2812 Alb. Mus.).
Dalmanites (*Anch.*) *africanus* (I. 857 Brit. Mus.).
Phacops (*Bouleia ?*) *Sharpei* (I. 858 Brit. Mus.).
,, sp. (70 S.A. Mus.).
Acidaspis Atherstonei (24103, 24104 Brit. Mus.).

Rozendal.

Homalonotus sp. (48774 Brit. Mus.).
Dalmanites (*Anchiopella*) cf. *africanus* (48774 Brit. Mus.)

Riet Kuil, Uitenhage.

Scaphiocoelia africana var. *elizabethae* (1173*a*, 1175, 1176 S.A. Mus.).

CONCLUSIONS.

The present author, in 1907,* drew the following conclusions from the evidence then available of the organic contents of the Bokkeveld Beds: (1) " The Bokkeveld fauna is more closely allied to that of the Devonian of South America than to that of any other area." All the recent evidence brought forward in this paper considerably strengthens this conclusion.

(2) " This southern Devonian fauna is marked by the special development of certain peculiar subgenera (*Anchiopella* and *Metacryphaeus* †), and by the predominance of other genera or groups (*e.g. Palaeoneilo, Nuculites*, ribbed centronellids, Bellerophontids of the *trilobatus* group), as well as by the absence or extreme rarity of many others, and of certain groups (cephalopods, corals, bryozoans)." To this list we may add the peculiar Brazilian phacopid, subgenus *Pennaia*, which Dr. Shand was the first to record in South Africa, although the earlier established species, *Ph. Gydowi* Schwarz, may now be assigned to it. Of peculiar genera of brachiopods we have now to add *Derbyina* and *Clarkeia*, while Kozlowski's new subgenera of *Phacops*, which he terms *Bouleia* and *Dereimsia*, and Clarke's *Phacopina* and *Proboloides*, are likewise also limited to the austral fauna, three of them being now recognised in the Bokkeveld fauna.

(3) " The affinities of this fauna are much closer to that of the Devonian of North America (eastern parts) than to the West European type."

Repeated allusions have been made in the foregoing descriptions of Bokkeveld species to their affinities with those of the Lower Devonian of Quebec and Maine; but with comparative rarity has any close alliance been observable to European forms. The special attention which the author has lately paid to the Lower Devonian of south-western England, and of the Rhenish area, convinces him of the accuracy of this conclusion. We cannot, however, still maintain that the Bokkeveld fauna is rather of a Middle than Lower Devonian type when compared with North American faunas, for the evidence on which this conclusion was based is found to be only slightly supported by the study of the greatly-increased series of Bokkeveld fossils and the much better preserved material. It must also be

* Reed, Geol. Mag., Dec. v, vol. iv, 1907, pp. 230, 231.

† Clarke (*op. cit.*, 1913, pp. 72, 79) was mistaken in believing that my *Metacryphaeus* was intended to include *Acaste convexa* Ulrich, *A. acutilobata* Knod, etc., and that his *Dalmanites australis* belonged to my *Anchiopella*.

emphasised that, although the affinities of many of the species are with Lower rather than Middle Devonian forms in Europe, there are no identical species, and a recognisable European element is conspicuous by its absence. The close relations between the South African and South American Devonian faunas and the common austral facies which they possess are demonstrated by the results embodied in this memoir, and the view that the South African assemblage is more closely linked to the European than is the South American must be abandoned.

The conclusion, however, which the author reached in 1907 that "the Bokkeveld fauna has a certain individuality of its own owing to the presence of certain peculiar genera (e.g. *Typhloniscus*) and species, in spite of its close relations to that of the South American Devonian," is fully justified. As Clarke (*op. cit.*, 1913, pp. 17–20, 68, 69) has pointed out, isolation has led to the development of local differences, though the degree of segregation and the persistence, position, and nature of the barriers between the various areas of the austral province are by no means certain. There is, however, a marked unity of character in spite of regional differentiation, and it is noteworthy that with increased knowledge of the fossil contents of the beds the distinctions and differences have grown less.

The presence of several elements in the Bokkeveld fauna may be more apparent than real, and the stratigraphical distribution of the species is still most imperfectly ascertained. But, as stated by the author in 1907, we may recognise a characteristic South African element and a strong South American element, as well as certain less-marked North American, and still more faintly-marked European elements, the latter being almost negligible.

Finally, the opinion may be again expressed that the fauna of the Bokkeveld series has a general homogeneity, and that the occasional local restriction of species appears to result chiefly from differences of environment and conditions of sedimentation or preservation, or even from the vagaries of collecting, and their distribution cannot, at any rate at present, be employed for the recognition of definite stratigraphical horizons, though it is probable that with increased knowledge of the vertical range of members of the fauna we shall be able to distinguish a certain zonal succession.

INDEX.

EXPLANATION OF PLATES.

Plate IV.

FIG.

1. *Placocystis africanus* sp. nov. $\times 2\frac{1}{2}$. Dorsal surface. Roadside cutting near Buffelskraal, De Doorns. (Sedgwick Museum, Cambridge.)
2. *Codaster* aff. *pyramidatus*, Shumard. Nat. size. Radial plate. Same locality. (Sedgw. Mus., Camb.)
3. *Lingula scalprum* Clarke. $\times 1\frac{1}{2}$. Hottentot's Kloof, Ceres. (H 67 Stellenbosch Museum.)
4. *Orbiculoidea ? aberrans* sp. nov. Nat. size. Brachial valve. Keurbosch, Hex River district. (289a Cape Univ. Coll.)

4*a*. Do. Portion of surface of same specimen. $\times 8$.

5. *Orthis* (*Dalmanella*) *satelles* sp. nov. $\times 2$. 200 yards from Triangle Station, Hex River Pass. (7203 S.A. Mus.)
6. *Rhynchonella* (*Clarkeia*) *Bodenbenderi* (Kayser). $\times 1\frac{1}{2}$. Internal cast of brachial valve. Ezelfontein, Ceres. (Sedgw. Mus., Camb.)
7. *Chonetes Rücki*, Ulrich, var. nov. *medialis*. $\times 2$. Impression of exterior of pedicle-valve. Touws River Road, Upper Hex River Valley. (207 Cape Univ. Coll.)
8. Do. Internal cast of same specimen. $\times 2$. (209 Cape Univ. Coll.)
9. *Orbiculoidea* (*Roemerella*) cf. *collis* Clarke. $\times \frac{3}{4}$. Brachial valve, posterior view. Driefontein, Clanwilliam. (6716 S.A. Mus.)

9*a*. Do. Same specimen, side view. $\times \frac{3}{4}$.

10. *Stropheodonta* cf. *Katzeri* Knod. Nat. size. Interior of pedicle-valve. Two miles N.E. of Ceres. (H 196 Stellenbosch Mus.)
11. *Stropheodonta Arcei* (Ulrich). $\times 1\frac{1}{4}$. Interior of pedicle-valve. Warm Bokkeveld. (11357 Brit. Mus.)
12. *Chonetes* cf. *Hallei* Clarke. $\times 1\frac{1}{4}$. Interior of brachial valve. Warm Bokkeveld. (B 45502 Brit. Mus.)
13. *Chonetes* (*Eodevonaria*) aff. *arcuata* Hall. $\times 1\frac{1}{2}$. Internal cast of pedicle-valve. Locality unknown. (C 10 Stellenbosch Mus.)
14. *Coelospira conjungens* sp. nov. $\times 1\frac{1}{2}$. Internal cast of pedicle-valve. Hottentot's Kraal, Ceres. (3895 S.A. Mus.)

Plate V.

1. *Spirifer euelpis* sp. nov. $\times 1\frac{1}{2}$. Pedicle-valve. Uitkomst, Ceres. (3821 S.A. Mus.)
2. *Derbyina whitiorum* Clarke, var. nov. *africana*. $\times 1\frac{1}{2}$. Internal cast of brachial valve. Gydo Pass. (B 45500 Brit. Mus.)
3. Do. Internal casts of pedicle-valve and of brachial valve. $\times 2$. Hottentot's Kraal, Ceres. (3891 S.A. Mus.)
4. *Retzia ?? Thomasi* sp. nov. $\times 1\frac{1}{2}$. Internal cast of pedicle-valve. Roadside cutting near Buffelskraal, De Doorns. (Sedgw. Mus., Camb.)

FIG.

5. *Meristella* cf. *Riskowskii,* Ulrich. Nat. size. Internal cast of pedicle-valve. Black's Farm, De Doorns. (H 64 Stellenbosch Mus.)
6. *Nuculites oblongatus* Conrad. ×1½. Internal cast of complete shell. Zwartberg Pass. (1623 S.A. Mus.)
7. *Nuculites Sharpei* Reed, var. nov. *remota.* Nat. size. Internal cast. Locality unknown. (796 S.A. Mus.)
8. *Ctenodonta Stowi* sp. nov. ×1½. Right valve. 300 yards from Triangle Station. (7777 S.A. Mus.)
9. Do. ×1½. Another specimen on same slab of rock. (7777 S.A. Mus.)
10. Do. ×1½. Internal cast of complete shell. De Doorns. (Sedgw. Mus., Camb.)

10*a*. Do. ×1½. Cardinal view of same specimen.

11. *Goniophora gydoensis* sp. nov. ×1½. Left valve. Gydo Pass, Ceres. (5436 S.A. Mus.)
12. *Modiomorpha* (*Modiella ?*) sp. Nat. size. Right valve. Road between Montagu and Triangle. (Stellenbosch Mus.)
13. *Janeia braziliensis* Clarke. Nat. size. Left valve of complete shell. Kamanassie River, Oudtshoorn. (5419 S.A. Mus.)

13*a*. Do. Nat. size. Right valve of same specimen.

14. *Modiomorpha montaguensis* sp. nov. Nat. size. Right valve. Road between Montagu and Triangle. (Stellenbosch Mus.)

Plate VI.

1. *Modiomorpha hexensis* sp. nov. Nat. size. Right valve. Roadside cutting near Buffelskraal, De Doorns. (Sedgw. Mus., Camb.)
2. Do. Nat. size. Anterior end of another specimen. Same locality. (Sedgw. Mus., Camb.)
3. Do. Nat. size. Left valve. Keurbosch, Hex River district. (280 Cape Univ. Coll.)
4. *Grammysia* (*Grammysioidea*) *scaphuloides* sp. nov. Nat. size. Right valve (crushed). Riet Vallei near Ceres. (192 S A. Mus.)
5. Do. Nat. size. Right valve. Ezelfontein, Ceres. (72 Cape Univ. Coll.)
6. *Palaeoneilo Orbignyi* Clarke. Nat. size. Right valve, internal cast. Ezelfontein, Ceres. (77 Cape Univ. Coll.)
7. Do. var. nov. *tenuilineata.* ×1½. Right valve. Keurbosch, Hex River district. (128 Cape Univ. Coll.)

7*a*. Do. do. Portion of surface of same specimen. ×8. (128 Cape Univ. Coll.)

8. Do. ×1½. Young individual, right valve. Laken Vlei, Ceres. (3791 S.A. Mus.)
9. *Myalina brevicardinalis* sp. nov. ×¾. Right valve. Locality unknown. (7202 S.A. Mus.)
10. *Sphenotomorpha Bodenbenderi* (Clarke), var. nov. *capensis.* Nat. size. Right valve. Bokkeveld. (2019 Kimb. Mus.)
11. *Palaeoneilo vindicata* sp. nov. Nat. size. Right valve. De Doorns. (Sedgw. Mus., Camb.)
12. Do. Nat. size. Left valve. Same locality. (Sedgw. Mus., Camb.)
13. *Cardiola ?* sp. ×4. Internal cast of complete shell. Zwartberg Pass. (Sedgw. Mus., Camb.)

PLATE VII.

FIG.

1. *Platyceras bokkeveldense* sp. nov. Nat. size. Koudeveld Berg. (2442 S.A. Mus.)
2. *Hyolithes D'Orbignyi* Kozl., var. nov. *capensis.* Nat. size. Ventral face. Zwartberg Pass. (2018 Kimb. Mus.)

2*a*. Do. Side view of same specimen.

2*b*. Do. Cross-section of same specimen.

2*c*. Do. Portion of surface of same specimen. $\times 10$.

3. *Conularia africana* Sharpe, var. nov. *albertensis.* Nat. size. Lateral view. Prince Albert. (2017 Kimb. Mus.)

3*a*. Do. Front view of same specimen.

3*b*. Do. Portion of surface of same specimen. $\times 2\frac{1}{2}$.

4. *Loxonema zwartbergense* sp. nov. Nat. size. Internal cast. Zwartberg Pass. (624 S.A. Mus.)

4*a*. Do. Impression of exterior of same specimen.

5. *Palaeoscurria Sharpei* sp. nov. Nat. size. Gydo Pass. (B. 45501 Brit. Mus.)

5*a*. Do. Side view of same specimen.

5*b*. Do. Portion of surface of same specimen. $\times 4$.

6. *Bellerophon* (*Patellostium*) *africanoides* sp. nov. Nat. size. Dorsal view. Locality unknown. (14 Cape Univ. Coll.)

6*a*. Do. Side view of same specimen.

6*b*. Do. Ventral view of same specimen.

7. *Acidaspis Atherstonei* sp. nov. $\times 1\frac{1}{2}$. Part of thorax and pygidium. Keurboom's River, Plettenberg Bay. (In. 24103 Brit. Mus.)

7*a*. Do. $\times 3$. Distal portions of several pleurae of same specimen.

7*b*. Do. $\times 1\frac{1}{2}$. Impression of some thoracic segments of same specimen.

8. *Proetus hexensis* sp. nov. $\times 1\frac{1}{2}$. Pygidium. De Doorns. (H 176 Stellenbosch Mus.)
9. *Tentaculites desuetus* sp. nov. Nat. size. Keurbosch. (135 Cape Univ. Coll.)
10. Do. Nat. size. Locality unknown. (7776 S.A. Mus.)

PLATE VIII.

1. *Dalmanites* (*Anchiopella*) *africanus* (Salter) sens. restr. Nat. size. Internal cast of complete individual. Cedarberg. (I 4047 Brit. Mus.)

1*a*. Do. Side view of same specimen.

1*b*. Do. Anterior view of same specimen.

1*c*. Do. Dorsal view of part of thorax of same specimen.

2. *Dalmanites* (*Cryphaeus ?*) cf. *rostratus* Kozlowski. $\times 1\frac{1}{2}$. Anterior view of margin of head-shield. Roadside cutting near Buffelskraal, De Doorns. (Sedgw. Mus., Camb.)
3. *Dalmanites* (*Cryphaeus*) cf. *Pentlandi,* Salter. $\times 1\frac{1}{2}$. Imperfect pygidium. Tunnel siding near Triangle. (447 Pretoria Mus.)
4. *Dalmanites* (*Proboloides*) *ensifer* sp. nov. Nat. size. Head-shield. Locality unknown. (C 2 Stellenbosch Mus.)

4*a*. Do. Front view of same specimen.

4*b*. Do. Side view of same specimen.

4*c*. Do. Inferior surface of same specimen.

4*d*. Do. $\times 3$. Eye of same specimen.

FIG.

5. *Dalmanites* (*Corycephalus ?*) *capensis* sp. nov. Nat. size. Head-shield and part of thorax. Klein Straat Station. (H 76 Stellenbosch Mus.)
6. Do. Another head-shield. Nat. size. Buffelskraal, De Doorns. (H 172 Stellenbosch Mus.)

Plate IX.

1. *Dalmanites* (*Anchiopella*) *Baini* sp. nov. $\times 1\frac{1}{2}$. Head-shield. Locality unknown. (Sedgw. Mus., Camb.)
2. Do Nat. size. Group of head-shields. Locality unknown. (7200 S.A. Mus.)
3. Do. Nat. size. Head-shield. Locality unknown. (139 Cape Univ. Coll.)
4. *Phacops* (*Calmonia*) *Lakei* sp. nov. $\times 1\frac{1}{2}$. Head-shield. Touws River Road. (232 Cape Univ. Coll.)
5. Do. $\times 2\frac{1}{2}$. Small complete individual. Same locality. (138 Cape Univ. Coll.)
6. *Phacops* (*Bouleia ?*) *Sharpei* sp. nov. $\times 1\frac{1}{2}$. Pygidium. Same locality. (198 Cape Univ. Coll.)
7. *Phacops* (*Pennaia*) *Gydowi* Schwarz. Nat. size. Complete individual. Boschluis Kloof, Prince Albert. (1167 S.A. Mus.)

7*a*. Do. $\times 2$. Pygidium of same specimen.

8. *Dalmanites* (*Acastella ?*) *pseudoconvexus* sp. nov. $\times 1\frac{1}{2}$. Head-shield. Hoenderfontein, Clanwilliam. (419 Kimb. Mus.)
9. Do. ? Nat. size. Imperfect pygidium. Same locality. (7201 S.A. Mus.)
10. *Dalmanites* (*Cryphaeus*) *caffer* Salt. (emend.). $\times 1\frac{1}{2}$. Head-shield. Touws River Road. (175 Cape Univ. Coll.)
11. Do. Nat. size. Front view of another head-shield. Same locality. (179 Cape Univ. Coll.)
12. *Phacops* (*Phacopina*) *hiemalis* sp. nov. ? Nat. size. Pygidium possibly referable to this species. Same locality. (243 Cape Univ. Coll.)
13. *Homalonotus* (*Burmeisteria*) *quernus* Lake ? $\times \frac{1}{2}$. Thoracic segments, probably belonging to this species. Ceres. (3292 Kimb. Mus.)

Plate X.

1. *Homalonotus* (*Burmeisteria*) *quernus* Lake. Nat. size. Head-shield. Locality unknown. (In. 24101 Brit. Mus.)
2. *Homalonotus* (*Burmeisteria*) *Herscheli* (Murch.) var. nov. *bituberculata*. Nat. size. Head-shield. Locality unknown. (I 254 Brit. Mus.)
3. *Homalonotus* (*Burmeisteria*) *Herscheli* (Murch.) var. nov. *rectisuturalis*. Nat. size. Head-shield. Locality unknown. (C 6 Stellenbosch Mus.)
4. *Homalonotus* (*Digonus*) *noticus* Clarke, var. nov. *africana*. $\times 1\frac{1}{2}$. Head-shield. Touws River Road. (247 Cape Univ. Coll.)
5. *Homalonotus* (*Burmeisteria*) *Herscheli* (Murch.) var. nov. *sodalis*. $\times \frac{1}{2}$. Head-shield. Locality unknown. (7199 S.A. Mus.)
6. *Homalonotus* (*Digonus*) *fontinalis* sp. nov. $\times 2\frac{1}{2}$. Nearly complete individual. Ezelfontein, Ceres. (Sedgw. Mus., Camb.)
7. *Homalonotus* (*Burmeisteria*) *Herscheli* (Murch.) var. nov. *rectisuturalis*. Nat. size. Head-shield. Cold Bokkeveld. (7193 S.A. Mus.)
8. *Phacops* (*Phacopina*) *hiemalis* sp. nov. Nat. size. Head-shield. (Type.) Winterhoek Mtns. (In. 24100 Brit. Mus.)

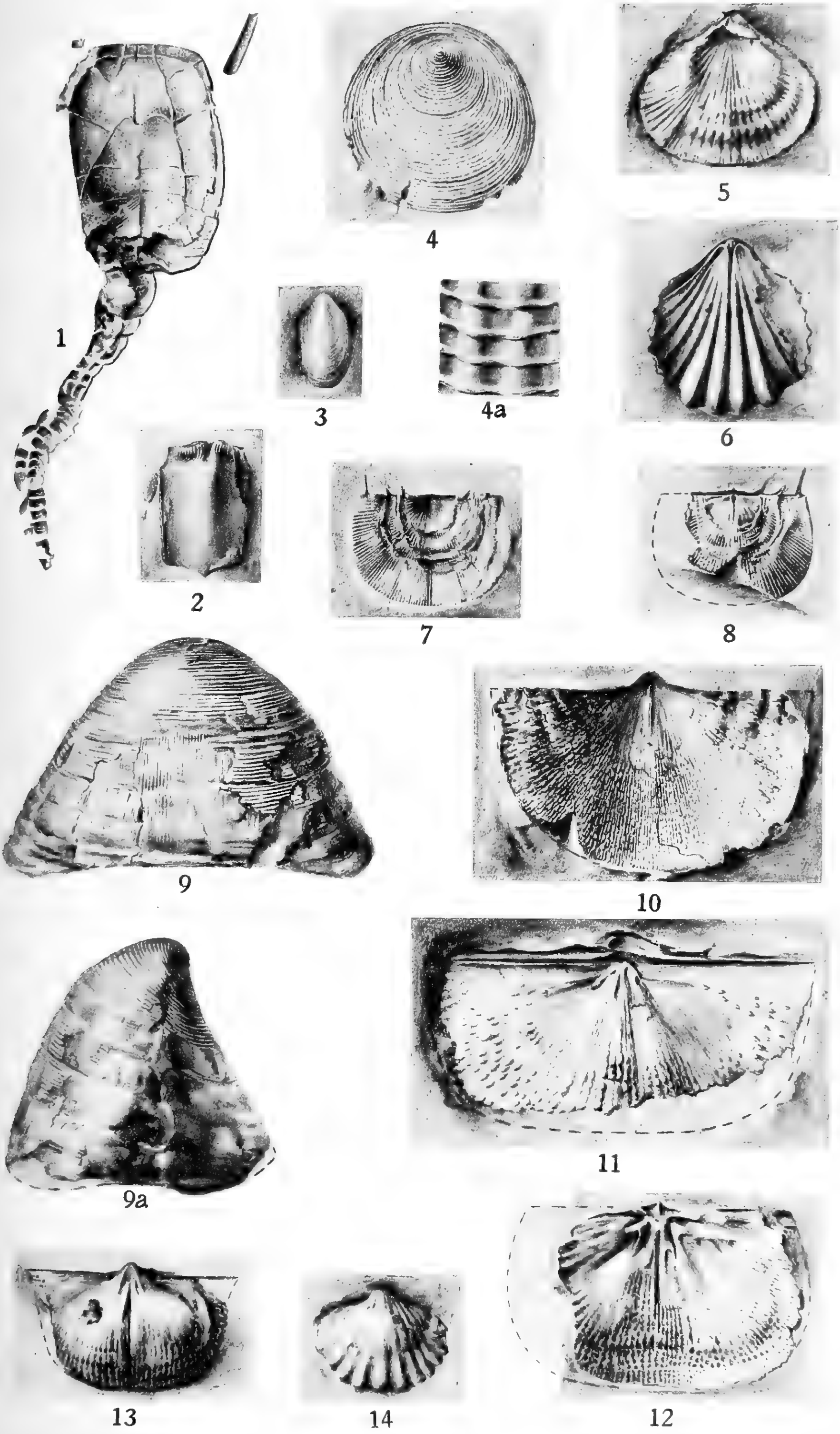
FIG.

9. *Phacops* (*Bouleia?*) *Sharpei* sp. nov. ×2. Pygidium. Keurbooms River, Plettenberg Bay. (I 858 Brit. Mus.)
10. *Cyphaspis Dereimsi* Kozl. ×2. Nearly complete individual. Roadside cutting near Buffelskraal, De Doorns. (Sedgw. Mus., Camb.)

PLATE XI.

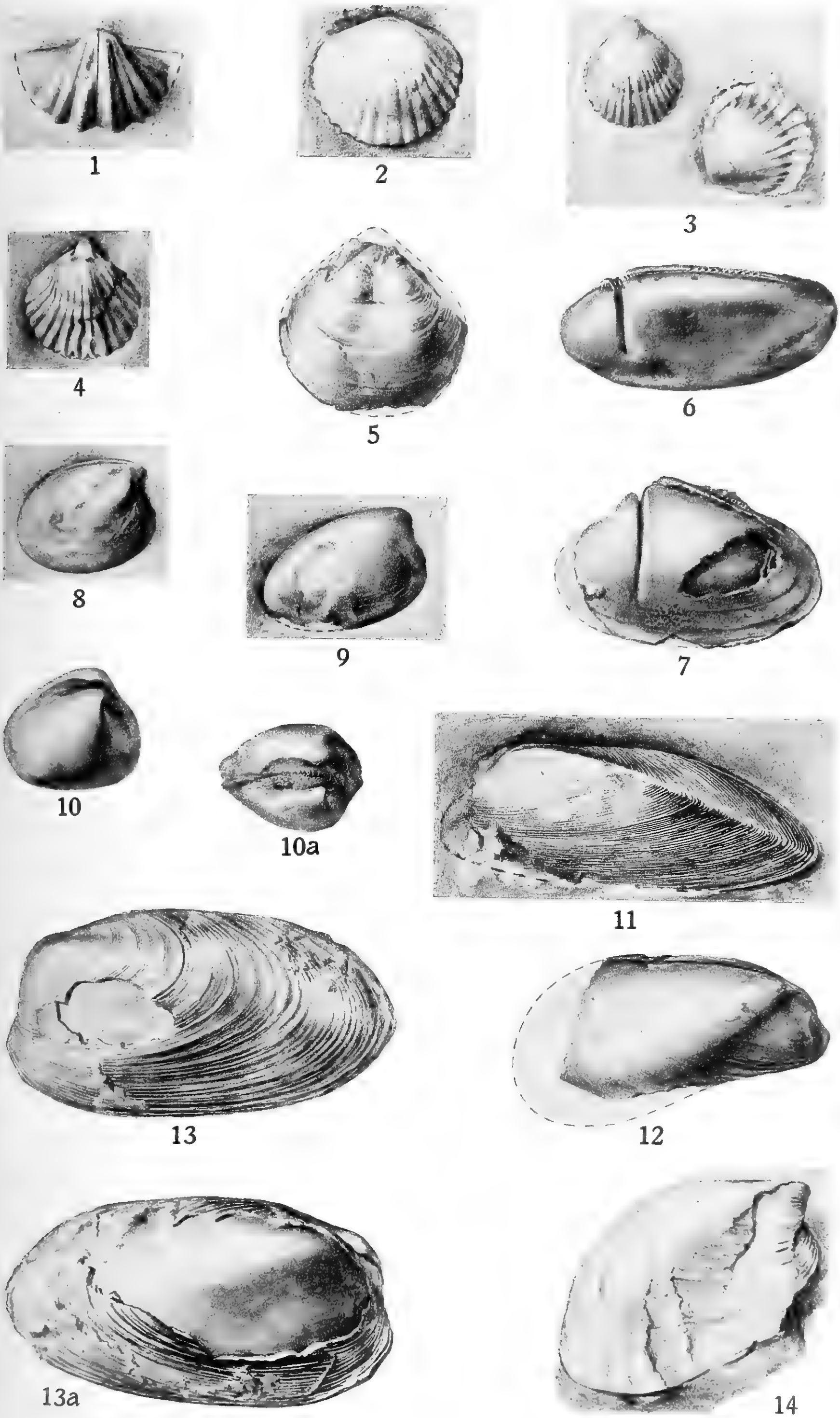
1. *Dalmanites* (*Cryphaeus*) *caffer* Salt. (emend.) var. nov. *albana*. ×$\frac{2}{3}$. Head-shield. Winterhoek. (69 Albany Mus.)
2. *Phacops* (*Pennaia*) *Gydowi* Schwarz. Nat. size. Head-shield. Cockscomb Mountains. (Bloemfontein Mus.)
3. *Proetus malacus* Lake. ×$1\frac{1}{2}$ (approx.). Complete enrolled individual. Cockscomb Mountains. (Bloemfontein Mus.)
4. *Dalmanites* (*Cryphaeus*) *caffer* Salt. (emend.). Nat. size. Thorax and pygidium. Osplaats, Hex River Valley. (E 483 Stellenbosch Mus.)
5. *Dalmanites* (*Hausmannia*) *Dunni* sp. nov. ×$\frac{1}{2}$. Imperfect pygidium. Gamka Poort. (3949 S.A. Mus.)
6. *Acidaspis capensis* sp. nov. Nat. size. Thorax and pygidium. Stettyn, Worcester district. (116*a* Cape Univ. Coll.)
7. Do. Impression of same specimen. (116*b* Cape Univ. Coll.)
8. *Phacops* (*Calmonia*) *impressus* Lake, var. nov. *vicina*. ×$1\frac{1}{4}$. Nearly complete individual. Gamka Poort. (418 Kimberley Mus.)
9. *Dalmanites* (*Cryphaeus*) cf. *australis*, Clarke. ×$1\frac{1}{4}$. Head-shield. Hottentot's Kloof, Ceres. (3850 S.A. Mus.)
10. *Dalmanites* (*Cryphaeus*) cf. *Pentlandi* Salter. Nat. size. Impression of thorax and pygidium. De Doorns. (2463 S.A. Mus.)

(Plates IX and XI are from photographs of the specimens.)



E. T. Talbot, del.

BOKKEVELD FOSSILS.



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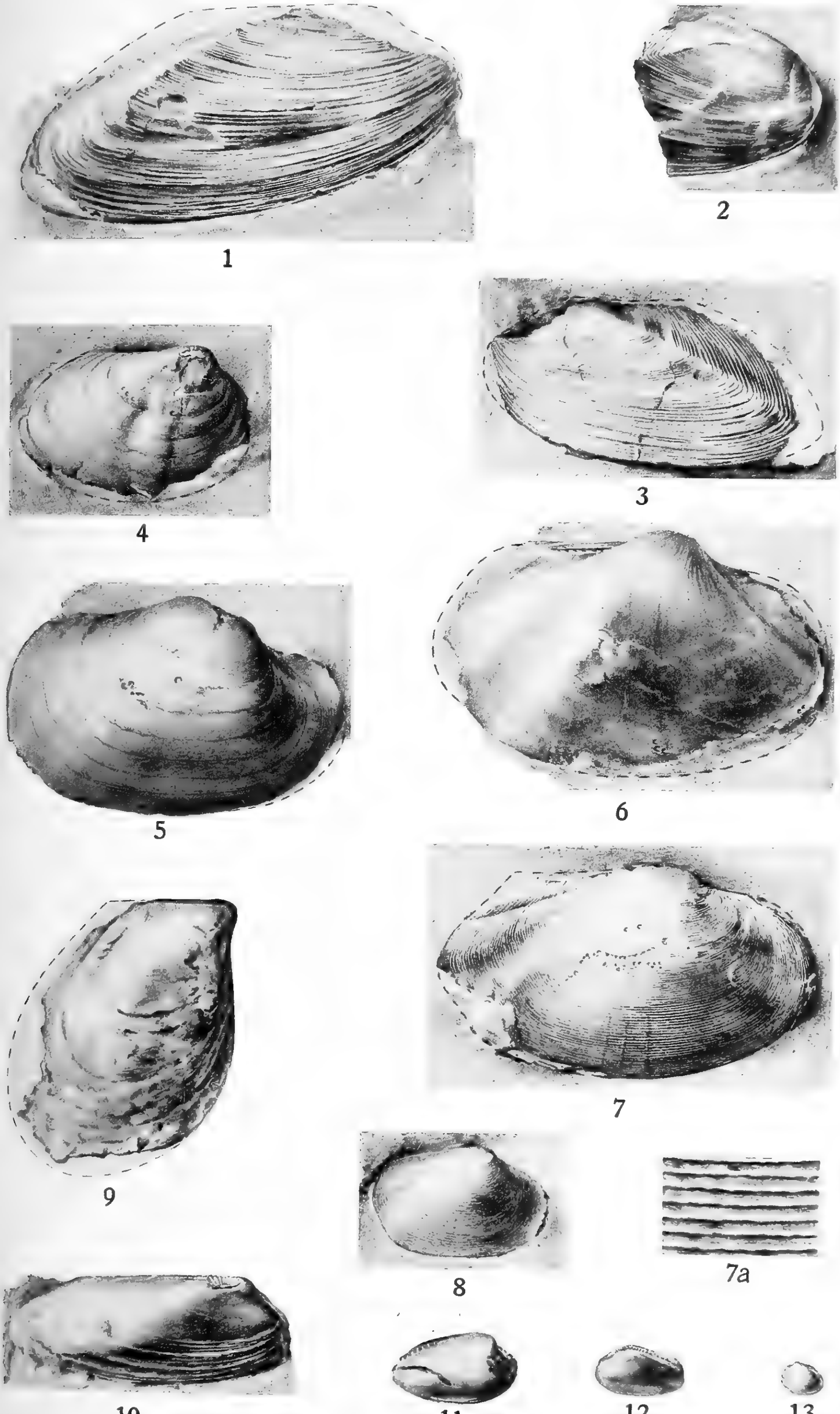

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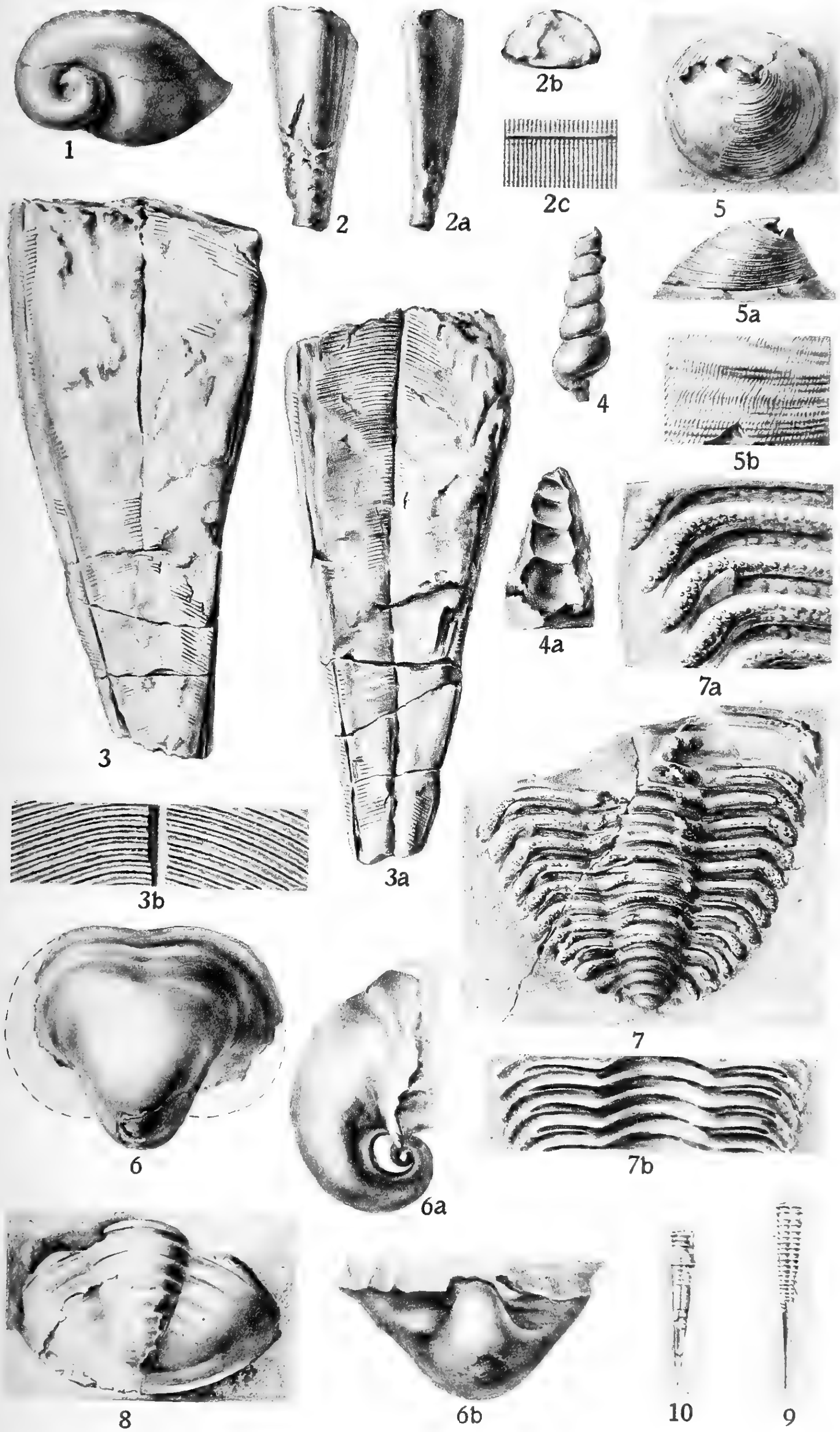

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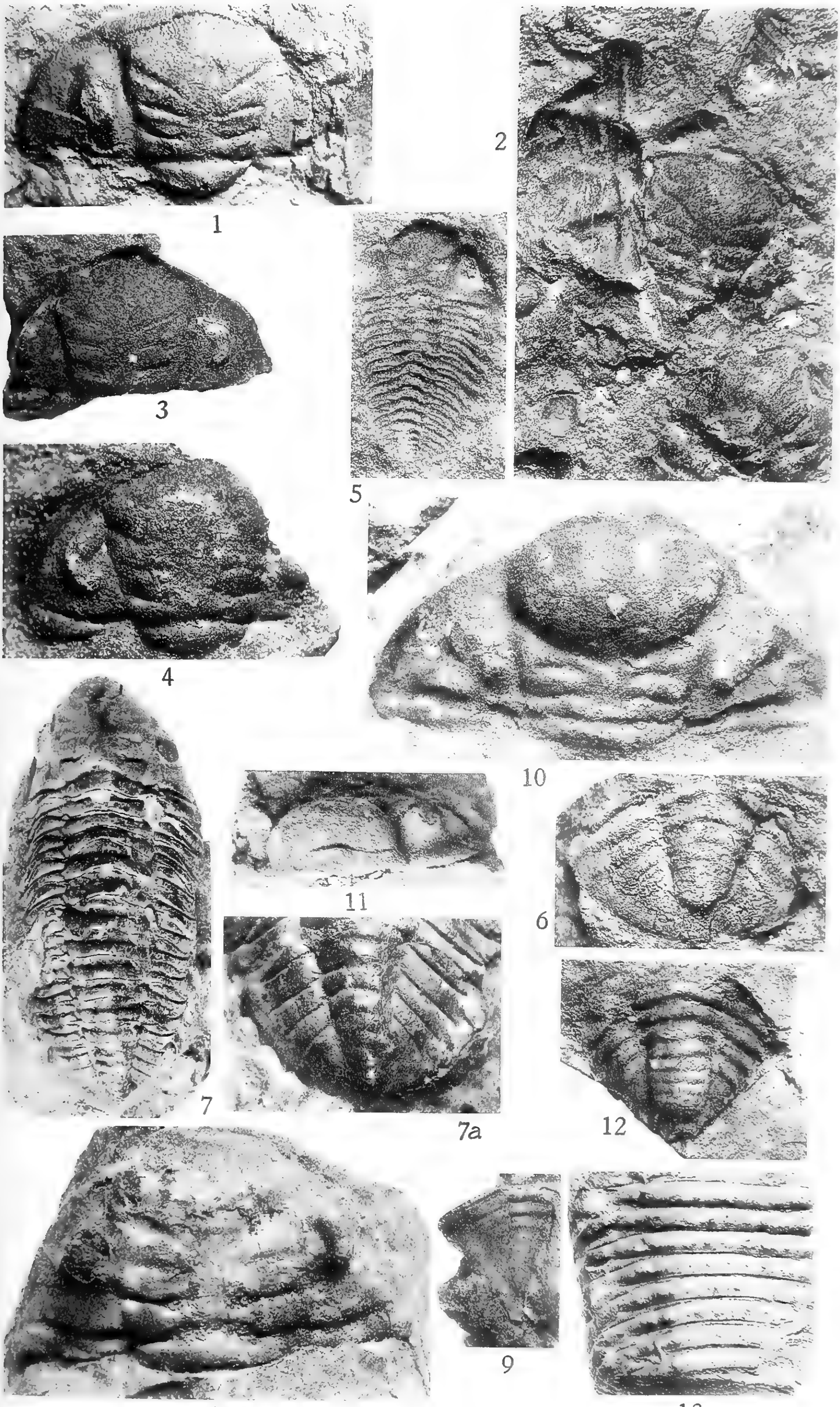
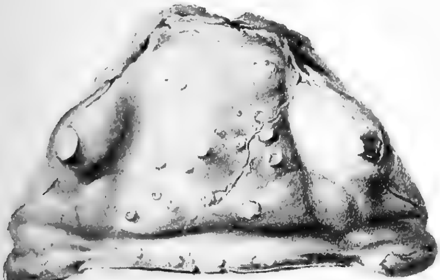


W. Tams, photo.

BOKKEVELD FOSSILS.



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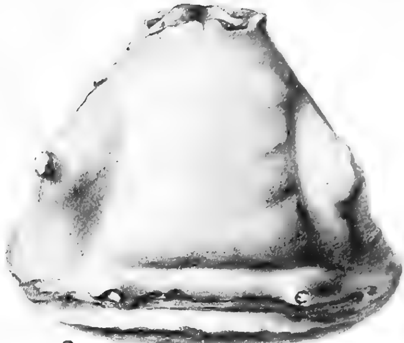

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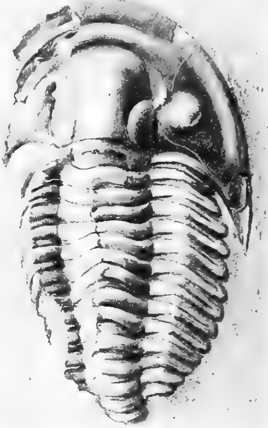

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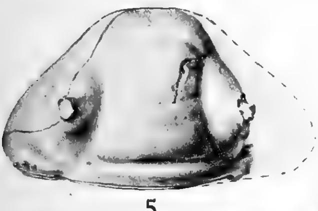

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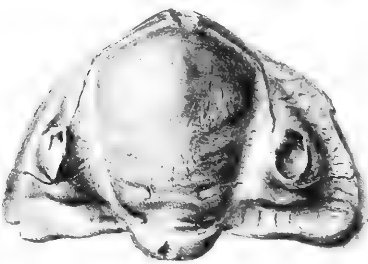

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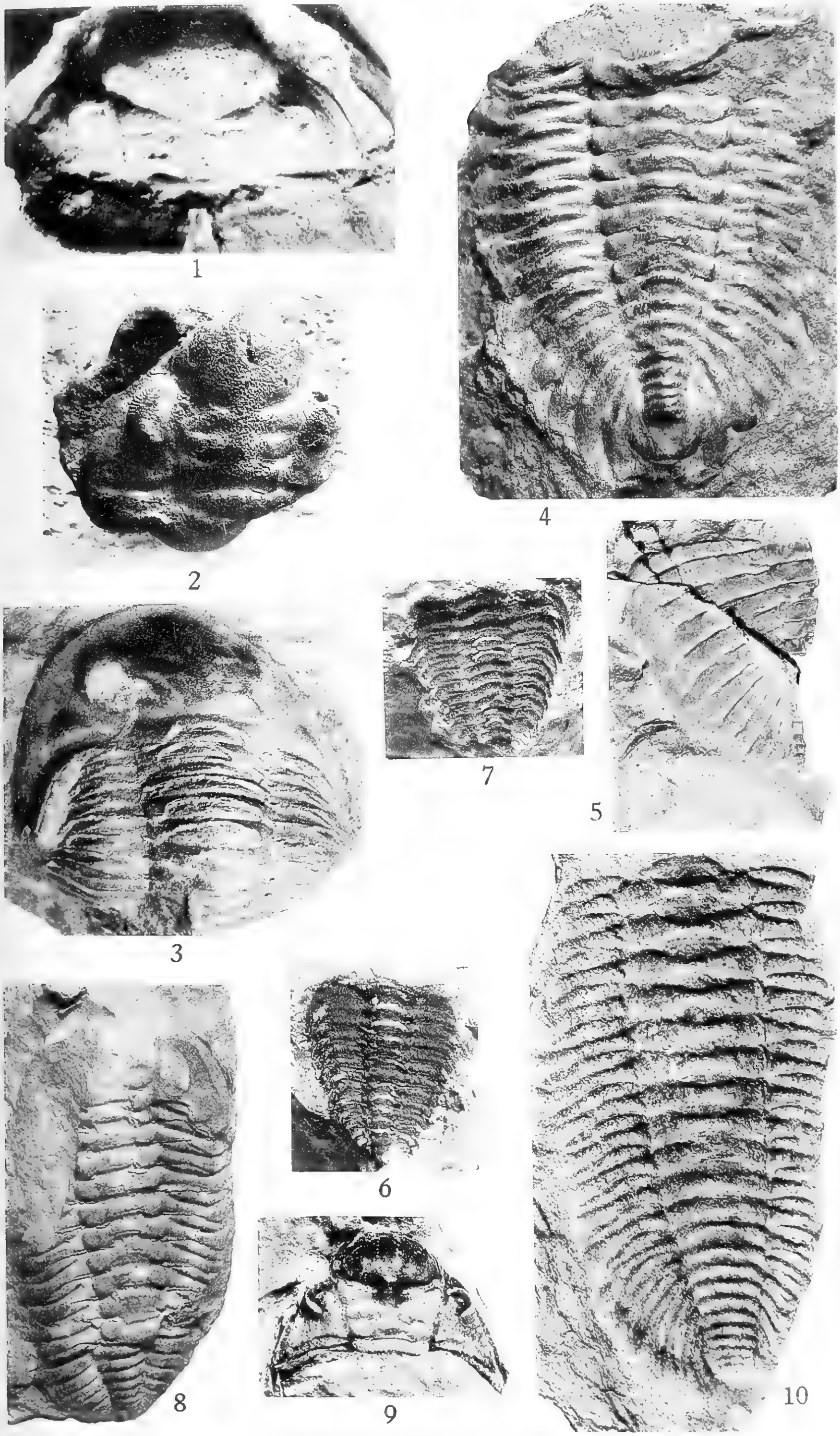
E. T. Talbot, del.

BOKKEVELD FOSSILS.



W. Tams, photo.

BOKKEVELD FOSSILS.

3. *Investigations in South African Fossil Reptiles and Amphibia* (Part 13).—By S. H. Haughton, B.A., D.Sc., F.G.S., Hon. Curator, Palaeontological Collections.

13. Descriptive Catalogue of the Amphibia of the Karroo System. (With 19 Text-figures.)

Order LABYRINTHODONTIA.

Grade RACHITOMI.

"Labyrinthodonts with ossified basioccipital and basisphenoid Occipital condyle triple or double. Pterygoids usually with a medium-sized palatal part, interpterygoid vacuities of medium to large size. Pterygoids articulating with both parasphenoid and basisphenoid.

"Tabulars and dermosupra-occipitals with occipital flanges. Paroccipital always visible from behind.

"Vertebrae rachitomous, *i.e.* with small paired pleurocentra and half-moon-shaped intercentra." (Watson.)

Fam. Rhinesuchidae, Watson.

1919. Watson, Phil. Trans., B. 209, p. 65.

"Rachitomi with somewhat depressed skulls, orbits small and far back, pterygoids not reaching the prevomers, interpterygoid vacuities of large size, no definite basipterygoid processes. Occipital condyle double. Clavicles expanded. Pubis ossified." (Watson.)

Gen. rhinesuchus, Broom.

1908. Broom, Ann. S. Afr. Mus., vol. iv, pt. 7, p. 373.
1911. *Myriodon*, van Hoepen, Ann. Transv. Mus., vol. iii, pt. 2, p. 103.
1915. Haughton, Ann. S. Afr. Mus., vol. xii, pt. 3, p. 66.
1916. *Uranocentrodon,* van Hoepen, Ann. Transv. Mus., vol. v, pt. 4, p. 217.
1919. Watson, Phil. Trans., B. 209, p. 10.

"Medium-sized to large temnospondylous labyrinthodonts.

"Skull triangular, rounded in front, median length slightly greater than breadth. Eyes wholly in posterior half of skull. Otic notch present. Bones of skull-roof complete. Maxillary and dentary each carrying a row of uniform teeth, slightly decreasing in size posteriorly. Prevomer carrying one or more large tusks, a few medium-sized teeth, and covered (together with the major parts of the parasphenoid and the pterygoid) with minute denticles. Palatine with row of teeth similar to those on the maxilla. Small trans-palatine with teeth present. Coronoid carries a number of denticles on upper surface." (1915.)

Rhinesuchus whaitsi, Broom.

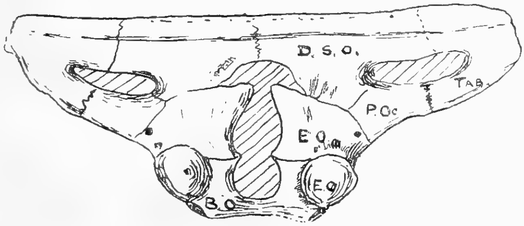
1908. Broom, *loc. cit.*, p. 373, pl. xlvi, fig. 3.
1915. Haughton, *loc. cit.*, p. 67, pl. xii, figs. 3, 4, text-fig. 7.
1919. Watson, *loc. cit.*, p. 11, fig. 3.

This is the type species of the genus, and was founded on a weathered basicranial portion of a skull found together with other fragmentary parts of the same skull. A complete skull from Beaufort West was described briefly in 1915; the only other specimen known to me is the posterior half of a skull from the *Tapinocephalus* beds of Blaauw Krantz, Prince Albert, C.P., which is encrusted with a thin layer of matrix that has so far resisted all attempts at removal.

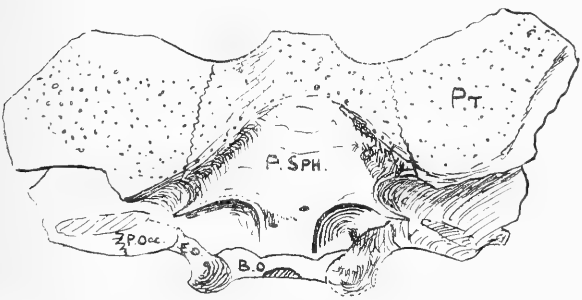
All these specimens are in the collection of the South African Museum, and have been re-examined in the light of Watson's paper; and examination of the two described specimens leads to the conclusion that the figure given by Watson, which is based on a drawing by Broom, requires certain emendations.

The type specimen (S.A.M., Cat. No. 1212) shows the following features: The basioccipital is large and forms the base of the foramen magnum, apparently completely separating the exoccipitals from one another; the posterolateral corners of the bone are overlain by the exoccipitals. The exoccipital condyle is fairly small. The exoccipital is a short, high bone reaching up to the dermosupra-occipital and having a flange on the upper side of the foramen magnum for the support of the cartilaginous supraoccipital. It is separated from the tabular by the paroccipital and from the pterygoid by a vertical wall of the parasphenoid which forms the lower border of the fenestra ovalis. The bone is perforated low down on its lateral face by the hypoglossal foramen. The epipterygoid has a powerful ascending process, but apparently no otic extension.

In the paratype (S.A.M., Cat. No. 3009) the sutures of the palate are extremely difficult to discern, but on the whole those given by Dr. Broom seem to be correct. It seems to me possible that, as mentioned in my original description, the prevomer passes down outside the palatal vacuity almost to meet the pterygoid—the whole of the mass of denticles in front of the vacuity then lying on the prevomer, and none on the palatine. This, however, is doubtful—but in *Eryops* the prevomer and pterygoid meet and exclude the



TEXT-FIG. 1.—Occiput of type of *Rhinesuchus whaitsi*, Broom.



TEXT-FIG. 2.—Palatal view of type of *Rhinesuchus whaitsi*, Broom.

palatine from the vacuity, and in *Rhinesuchus* it is to be expected that the structure would show but a slight advance on that.

The chief error in the figure given by Watson is in the omission of the anterior palatal vacuities. That these are present seems to me undoubted. They are somewhat small and may coalesce in the middle line for a short distance. In the figure, too, a row of teeth should be shown as lying along the whole of the border of the internal nares. In Watson's figure the basicranial region of the skull has been drawn from the type specimen and not from the complete skull.

Type.—Fragmentary skull. S.A.M., Cat. No. 1212.

Locality.—Near Fraserburg Road Station, Cape Province.

Horizon.—Lower Beaufort Beds (*Tapinocephalus* zone).

Distribution.—Lower Beaufort Beds; *Tapinocephalus* and *Endothiodon* zones.

Rhinesuchus senekalensis (van Hoepen).

1911. *Myriodon senekalensis*, van Hoepen, *loc. cit.*, p. 103, pls. i, ii.
1912. *Rhinesuchus major*, Broom, Trans. Zool. Soc. S. Afr., vol. xiv, p. 79, pl. xiii, figs. 1, 2.
1915. Haughton, *loc. cit.*, p. 70, pl. xii, figs. 1, 2.
1919. Watson, *loc. cit.*, p. 52, fig. 29B.

The basicranial region of the skull in this species still remains unknown. In view of the palatal similarity between *Rhinesuchus* and the form described later as *Laccosaurus*, the generic position of the Senekal fossils must remain doubtful until the cranial structure is worked out. It is possible that the form will prove to be similar to that described as *Laccosaurus*; the geological horizon of the Senekal fossils makes that a feasible possibility. In that case van Hoepen's name *Uranocentrodon* has priority.

Type.—Portion of skull in Transvaal Museum, Pretoria.

Locality.—Senekal, Orange Free State.

Horizon.—Middle Beaufort Beds (*Lystrosaurus* zone).

The South African Museum possesses a portion of a skull and lower jaw from the type locality, from which no further details can be derived.

Rhinesuchus africanus (Lydekker).

1890. *Eryops africanus*, Lydekker, Quart. Journ. Geol. Soc., vol. xlvi, p. 291, pl. xii, fig. 2.
1915. Haughton, *loc. cit.*, p. 76.

The specimen which I referred to this species in 1915 is certainly not a *Rhinesuchus*, as the basioccipital, if present, plays no part in the formation of the condyle.

The type of the species is a portion of a lower jaw. Little is known of the differences, if any, which exist between the mandibles of the related *Rhinesuchus*, *Laccosaurus*, and *Laccocephalus*; and in view of the fragmentary nature of the type this species will probably remain unidentified.

Type.—Mandibular ramus in British Museum.

Locality.—" Karroo."

Horizon.—Unknown.

Rhinesuchus capensis, sp. nov.

This species is founded on a skull in the South African Museum collection—Cat. No. 7419. The skull is large, resembling in general appearance the skull of *R. senekalensis*. Its chief dimensions are :

Greatest length	520–530 mm.
Length of top of skull in median line	450 ,,
Greatest breadth	360 ,,
Snout to front of nostril	25 ,,
Snout to front of orbit	270 ,,
Distance, orbit to nostril	210 ,,
Interorbital width	60 ,,
Greatest width across tabulars	160 ,,
Back of skull to pineal foramen	83 ,,

The skull is not in a good state of preservation. Sutures are almost impossible to determine—the skull seemingly being that of an aged animal in which all, or most of, the bones have become co-ossified. The general proportions can be seen from the figures on pp. 228, 229.

The skull is slightly narrower than that of *R. senekalensis* and considerably than that of *R. whaitsi*. The interorbital width is greater than in *senekalensis*. As far as can be seen, the dentition is that of a typical *Rhinesuchus* ; the parasphenoid, pterygoids, and prevomers all carry numerous denticles.

In the basicranial region the skull shows an advance on *R. whaitsi* in that the basioccipital is almost wholly invisible in posterior view—the exoccipitals apparently meeting below the foramen magnum and above the posterior edge of the parasphenoid. The latter bone is typically that of a *Rhinesuchus*.

This form may be co-specific with *R. africanus* ; but as the type possesses no lower jaw, the matter must remain in doubt.

Type.—Badly preserved skull, S.A.M., Cat. No. 7419.

Locality.—Spitzkop, Graaff Reinet, C.P.

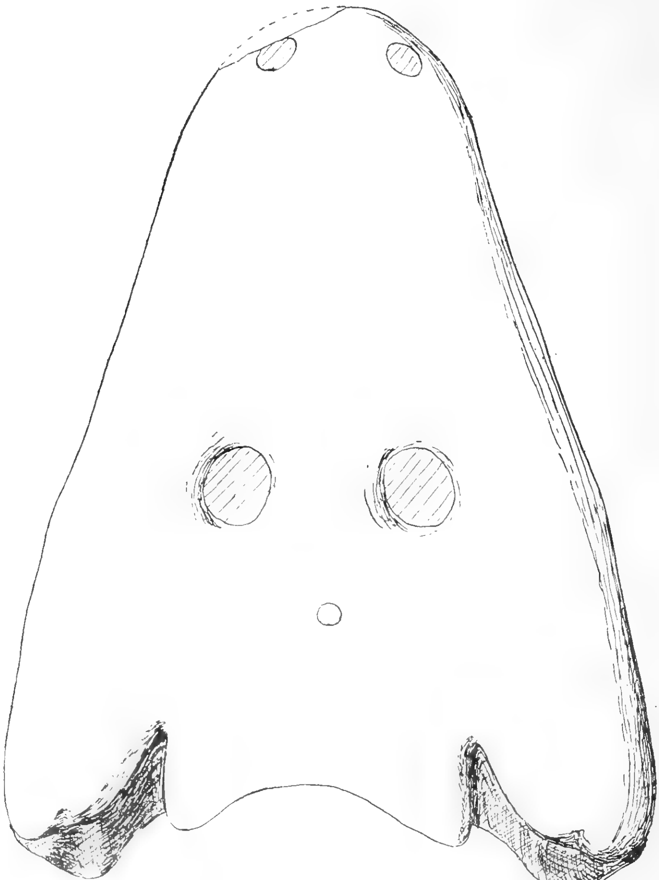
Horizon.—Lower Beaufort Beds (*Endothiodon* zone).

Gen. LACCOCEPHALUS, Watson.

1919. Watson, Phil. Trans., B, 209, p. 18.

Although placed by Watson in the Rachitomi, this form seems to approximate to the Stereospondyls in that " the exoccipital seems to articulate with the tabular very much as in *Capitosaurus*." It does

not, however, reach forward to the pterygoid, so that the parasphenoid forms a very small part of the border of the bony fenestra vestibuli. It may be looked upon as an advanced member of the Rachitomi or an early form of the Stereospondyli. The basioccipital and basi-



TEXT-FIG. 3.—*Rhinesuchus capensis,* sp. nov. Dorsal view of type skull.

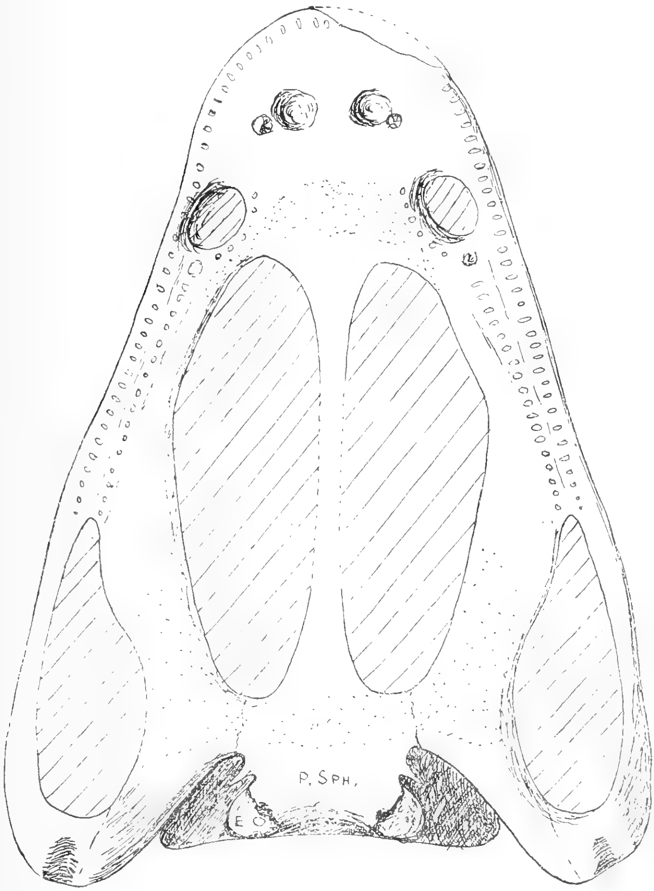
sphenoid are both ossified but not very large, and the latter seems to have no definite basipterygoid processes. The pro-otic is reduced; the epipterygoid is larger than in *Eryops*, but the otic process is still undeveloped. There are no small teeth on the palate.

Watson has shown (*loc. cit.*, p. 53) that the genus is intermediate between *Eryops* and *Capitosaurus*, and stands nearer the latter than does *Rhinesuchus*.

Laccocephalus insperatus, Watson.

1919. Watson, *loc. cit.*, p. 18, fig. 10, pl. ii, figs. 1, 2.

The only described species—known from an incomplete skull which



TEXT-FIG. 4.—*Rhinesuchus capensis*, sp. nov. Palatal view of type skull.

shows the sutures of the basicranium by means of fractures. Type specimen large.

Type.—Incomplete skull—British Museum, Cat. No. R 532.

Locality.—" Mr. Hope's Farm, Orange Free State."

Horizon.—Unknown.

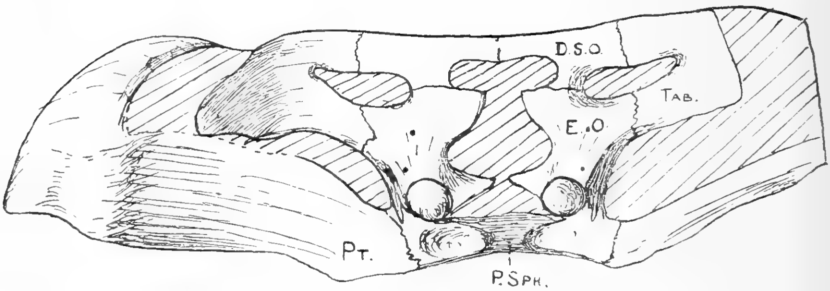
Gen. LACCOSAURUS, nov. gen.

Closely allied to *Laccocephalus*, but distinguished generically by the presence of small teeth or denticles on the palate as in *Rhinesuchus.*

Laccosaurus watsoni, sp. nov.

This species is founded on a single, beautifully preserved skull which lacks part of the antorbital portion, collected by the Rev. J. H. Whaits.

The median length was probably 230 mm., while the maximum width was 190 mm. The orbits lie in the posterior half of the skull, are small, and near the middle line ; the nostrils are very far forward.



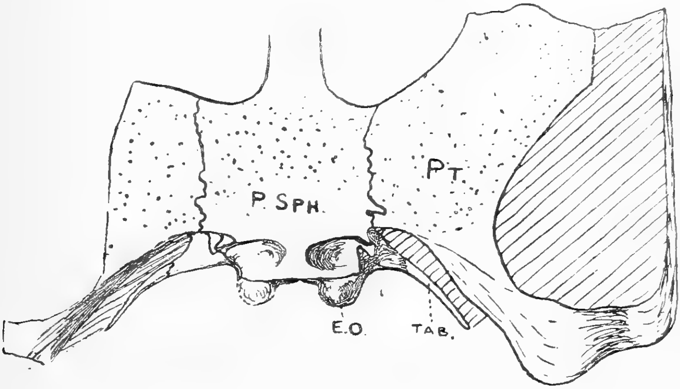
TEXT-FIG. 5.—Occipital view of type skull of *Laccosaurus watsoni*, gen. et sp. nov.

The chief features of the bones on the top of the skull are the large size of the nasals, the narrow frontals, the fact that the suprasquamosal forms part of the border of the otic notch and completely separates the squamosal from the tabular, and the fact that the tabular appears more on the occipital view than on the top surface of the skull. In general shape the skull is longer than that of *Rhinesuchus whaitsi.*

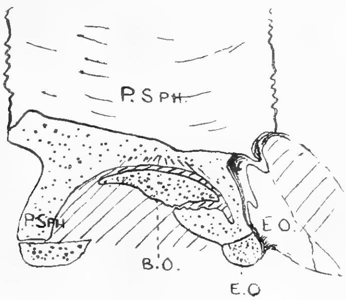
Parasphenoid.—The processus cultriformis is not displayed. The posterior part of the bone is as in *Rhinesuchus*, concave from side to side, articulating laterally with the pterygoids in interlocking sutures. The ventral surface of the bone is covered with denticles save for a bare portion posteriorly. Just mesial to the pterygoid suture the free posterior border has a little process similar to that of *Lydekkerina* and *Rhinesuchus* which supports a nearly vertical flange running up to the suture with the exoccipital. Mesial to this flange the parasphenoid is deeply excavate on each side of a median portion which gradually slopes upwards to a free posterior margin lying between and in advance of the exoccipital condyles. There is thus an approximation to the transverse ridge seen in *Capitosaurus.*

An irregular fracture shows the bone in its posterior half to have been broadly grooved. In the central channel lies the basioccipital, on either side of which the parasphenoid rises to meet the exoccipital.

Basioccipital.—This is a well-ossified zone, seen only in section. It plays no part in the formation of the double condyle. Its postero-



TEXT-FIG. 6.—Palatal view of back part of type skull of *Laccosaurus watsoni*, gen. et sp. nov.



TEXT-FIG. 7.—Irregular fracture across base of type skull of *Laccosaurus watsoni*, showing basioccipital resting on parasphenoid.

lateral corners are overlain by inwardly and forwardly directed processes of the exoccipitals as in *Laccocephalus insperatus*.

Exoccipital.—Seen from behind, the bone rises from the condyle as a pillar dividing superiorly into two parts. One forms the lateral border of the foramen magnum, has a strong mesial step, with a platform for the articulation of a cartilaginous supraoccipital, forming the inner border of the post-temporal vacuity. The other branch underlies the post-temporal vacuity and articulates with the tabular. The exoccipital has a powerful sutural union with the parasphenoid,

but does not reach the pterygoid. On its inner side it sends forward a process to overlie in part the basioccipital.

It is perforated on its posterior face between the condyle and the post-temporal vacuity by a nutritive foramen. At the lateral edge of the bone just above the level of the condyle is a small foramen for the exit of the XIIth nerve, while in advance of this on the side face of the bone is a large foramen for the exit of the Xth nerve.

Tabular.—The tabular is seen much more in occipital view than from above. It forms more than half the border of the post-temporal vacuity, articulating with the dermosupra-occipital above the vacuity and the exoccipital below. Laterally, the tabular has a large thin flange stretching backwards and outwards, forming the inner border of the otic notch.

Pterygoid.—The pterygoid is of the usual form. Its palatal surface is largely covered with denticles. The quadrate ramus is fairly long.

Type.—Nearly complete skull, S.A.M., Cat. No. 4010.

Locality.—Ferndale, Graaff Reinet, C.P.

Horizon.—Lower Beaufort Beds (*Cistecephalus* zone).

Fam. LYDEKKERINIDAE, Watson.

1919. Watson, Phil. Trans., B, 209, p. 66.

"Rachitomi with depressed skull, orbits small and in the middle of the length. Interpterygoid vacuities large, no definite basipterygoid processes. Occipital condyle double. Clavicle expanded, pubis unossified." (Watson.)

Gen. LYDEKKERINA, Broom.

1915. Broom, P.Z.S., p. 366.
1919. Watson, Phil. Trans., B, 209, p. 12.

Characters as for family.

Lydekkerina huxleyi (Lydekker).

1889. *Bothriceps huxleyi*, Lydekker, Ann. Mag. Nat. Hist., Ser. 6, vol. iv, p. 476.
1890. ,, ,, ,, Cat. Foss. Rept. Amphib., vol. iv, p. 172, fig. 41.
1912. ,, ,, Watson, Ann. Mag. Nat. Hist., Ser. 8, vol. x, p. 585, fig. 6.
1915. Broom, *loc. cit.*, p. 366, text-fig. 3.
1919. Watson, Phil. Trans., B, 209, figs. 4–9.

The papers by Broom and Watson have given an almost complete description of this species—Broom of the dorsal surface of the skull, Watson of the palatal and occipital aspects and of the post-cranial skeleton as far as it is known.

The South African Museum possesses one or two specimens, all from the *Lystrosaurus* zone of Harrismith, O.F.S. Specimen No. 3525 shows the dorsal view and part of the palate of the left half of a skull. The bones of the dorsal surface are arranged as in Broom's description. The lachrymal reaches the nostril in front but does not extend back to the orbit.

The processus cultriformis of the parasphenoid is narrower than in the figure given by Watson of "the palate of an average specimen." Our specimen, further, is smaller than the average. The anterior portion of the parasphenoidal plate and the adjoining portions of the pterygoids are furnished with numerous minute denticles.

The only other feature of note is in the occipital view. Here the sutures between the squamosal, quadrate, and pterygoid are slightly different from those in the British Museum specimen R 506, and in addition to the foramen on the suture between the quadratojugal and the quadrate, which is not actually seen in our specimen, the quadrate is pierced by two other foramina.

Type.—In British Museum.

Locality.—Near Edenburg, Orange Free State.

Horizon.—Middle Beaufort Beds. *Lystrosaurus* zone.

Fam. MICROPHOLIDAE, Watson.

1919. Watson, Phil. Trans., B, 209, p. 66.

"Small Rachitomi with a depressed skull. Large laterally placed orbits and otic notches. Interpterygoid vacuities very large. Definite basipterygoid processes. Occipital condyle double. Clavicle not expanded." (Watson.)

Gen. MICROPHOLIS, Huxley.

1859. Huxley, Quart. Journ. Geol. Soc., vol. xv.

1913. Watson, Geol. Mag., N.S., Dec. v, vol. x, p. 340.

Characters as for family.

Micropholis stowi, Huxley.

1859. Huxley, *loc. cit.*

1876. *Petrophyne granulata*, Owen, Desc. Cat. Foss. Rept. S. Afr., p. 67, pl. xx, figs. 13–20.

1913. Watson, *loc. cit.*, p. 340, figs. 1–5.
1919. „ Phil. Trans., B, 209, p. 20.

Watson considers this an advanced type, on account of the following features :—

1. The unique arrangement of the bones of the top of the skull—the frontal forms part of the orbital border, the lachrymal stretches from the nostril to the orbit, the jugal is very small, and the supratemporal is much reduced, while the suprasquamosal is large.
2. The enormous interpterygoid vacuities.
3. The slender clavicles and great reduction of the cleithra.
4. The very slender humerus.
5. The loss of the grooves for the lateral line sense organs.

Type.—Incompletely preserved skull in British Museum.

Locality.—Rhenosterberg, Graaff Reinet, C.P.

Horizon.—Upper Beaufort Beds (*Procolophon* zone).

Grade STEREOSPONDYLI.

"Labyrinthodonts with reduced basioccipital and basisphenoid. Occipital condyle double. Pterygoids with a reduced palatal ramus, interpterygoid vacuities large or very large. Pterygoids supported by the parasphenoid. Exoccipital meeting the occipital flange of the tabular so as to hide the paroccipital in occipital view.

Vertebrae stereospondylous, *i.e.* with very reduced or absent pleurocentra and large intercentra." (Watson.)

Fam. Capitosauridae, Watson.

1919. Watson, Phil. Trans., B, 209, p. 67.

"Stereospondyls, with elongated skulls with a comparatively broad snout. Orbits small, near the middle line and far back." (Watson.)

Gen. capitosaurus, Munster.

1857. von Meyer, Palaeontographica, vol. vi, p. 221.
1908. Jaekel, Lethaea Geognostica, vol. ii, i, p. 13.
1912. Schroeder, Jahr. d. Kon. Preuss. Geol. Landesanstalt, vol. xxiii, p. 232.
1919. Watson, Phil. Trans., B, 209, p. 22.

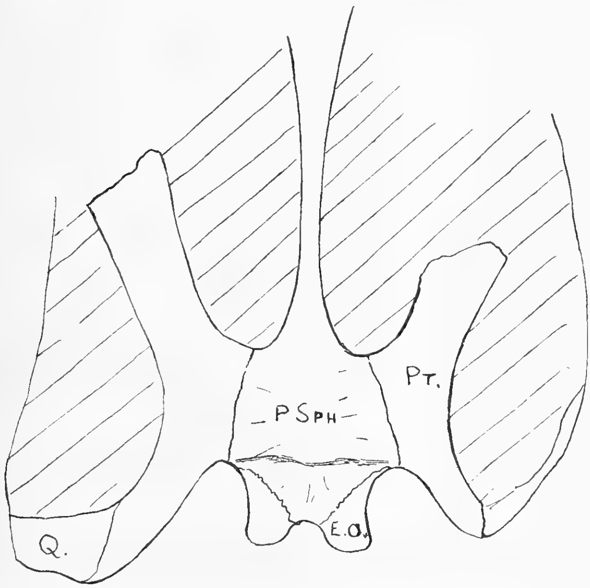
Skulls of medium to large size, with the otic notch open. Basioccipital, basisphenoid, paroccipital and pro-otic all reduced. Epi-

pterygoid greatly expanded. Exoccipital just meeting the pterygoid. Quadrate only slightly behind level of condyles.

Capitosaurus africanus, Broom.

1909. Broom, Ann. S. Afr. Mus., vol. vii, pt. 3, p. 271.

This species is founded upon an incomplete skull. The original description is very brief. There is in the collection of the South



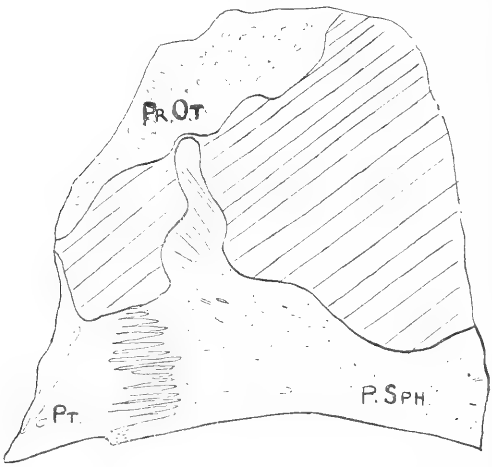
TEXT-FIG. 8.—*Capitosaurus africanus*, Broom. Palatal aspect of skull No. 3008.

African Museum (Cat. No. 3008) a skull collected by me at Winnaarsbaaken, Albert, C.P., which seems to belong to this species. The skull is complete save that the bones of the dorsal surface have almost entirely weathered away. The palatal surface of the posterior half has been developed, and the brain-case has been broken through in various directions in order to compare the structure with the account given by Watson of this genus.

That account, founded upon a skull to which he refers as *Capitosaurus* sp., is so full, that it is only necessary here to point out certain features which are worthy of note as being additional to, or different from, the description given by Watson.

Parasphenoid.—As in *Capitosaurus* sp., Watson, the parasphenoid ends in a free margin at the back of the skull below the condyles. In front of this the bone expands rapidly so that it forms a broad plate between the pterygoids. This plate is vaulted in the middle. The outer posterior corner of the bone just reaches the free edge of the skull. There is a slight ridge running across the lower surface of the bone at the level of the front of the exoccipital.

Basioccipital.—There is apparently no basioccipital preserved. The upper surface of the parasphenoid is concave, as in *Laccosaurus* ; but



TEXT-FIG. 9.—*Capitosaurus africanus*, Broom. Section of skull No. 3008, showing relations of pterygoid, pro-otic, and parasphenoid.

the whole of the space between it and the top of the skull is, as far as the fractures show, filled with matrix. One longitudinal fracture shows the ragged anterior end of an exoccipital lying above the parasphenoid ; a transverse fracture at the transverse ridge shows the parasphenoid with a lateral flange passing upwards to meet the pro-otic.

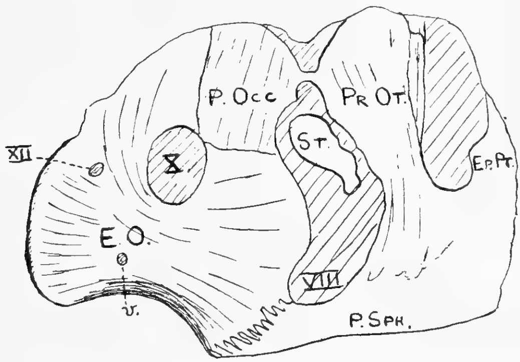
Exoccipital.—As in *Capitosaurus* sp., the bone forms the lower border of the bony fenestra ovalis. Seen from without, the body of the bone is perforated at the side by a large rounded foramen—the opening for the Xth nerve. Posterior to this is a much smaller opening, the exit for the XIIth nerve ; and below these is a small venous foramen. The upper anterior portion of the bone, which meets the pro-otic above the fenestra ovalis, seems to be of somewhat different texture from the main mass and is probably paroccipital.

The exoccipital, pterygoid, and parasphenoid all meet at the lower border of the fenestra ovalis.

The sutures between the pterygoid, epipterygoid, and pro-otic are difficult of determination. The epipterygoid has a large anterior ascending plate, which is separated by a deep notch from the posterior otic process. This latter is indistinguishable in the specimen from the pro-otic, which forms the anterior border of the fenestra ovalis.

The stapes is seen in section lying in the fenestra ovalis. It seems to pass upwards and outwards.

The sphenethmoid is a low elongate bone lying above the anterior



Text-fig. 10.—*Capitosaurus africanus,* Broom. Bones of right side of basicranial area and brain-case of skull No. 3008.

prolongation of the parasphenoid. It reaches upwards to the roof of the skull.

As far as can be ascertained this skull agrees closely with the description of *C. africanus,* Broom. Its chief point of difference from *C.* sp., Watson, is the absence of a basioccipital and the probable absence of a basisphenoid. As Watson has shown, the loss of these bones gradually takes place with the advance of the Stereospondyls, and even in *Capitosaurus* sp. the basioccipital is very much reduced. In *Cyclotosaurus* both bones are absent ; but this skull is less advanced than *Cyclotosaurus* in that there is no suture between the exoccipital and pterygoid to be seen in palatal view.

Type.—Fragmentary skull, S.A.M., Cat. No. 2360.

Locality.—Vaalbank, Albert, C.P.

Horizon.—Upper Beaufort Beds. *Cynognathus* zone.

Capitosaurus sp., Watson.

1919. Watson, Phil. Trans., B, 209, p. 22, figs. 11B, 12–16.

The skull designated thus by Watson is in the British Museum and was collected on the farm Watford, Albert, C.P., from the *Cynognathus* zone of the Upper Beaufort Beds. Watson has given a very full description of the bones of the brain-case, which has proved of very great value in linking together the various types of Stereospondyls.

Gen. KESTROSAURUS, gen. nov.

Kestrosaurus dreyeri, sp. nov.

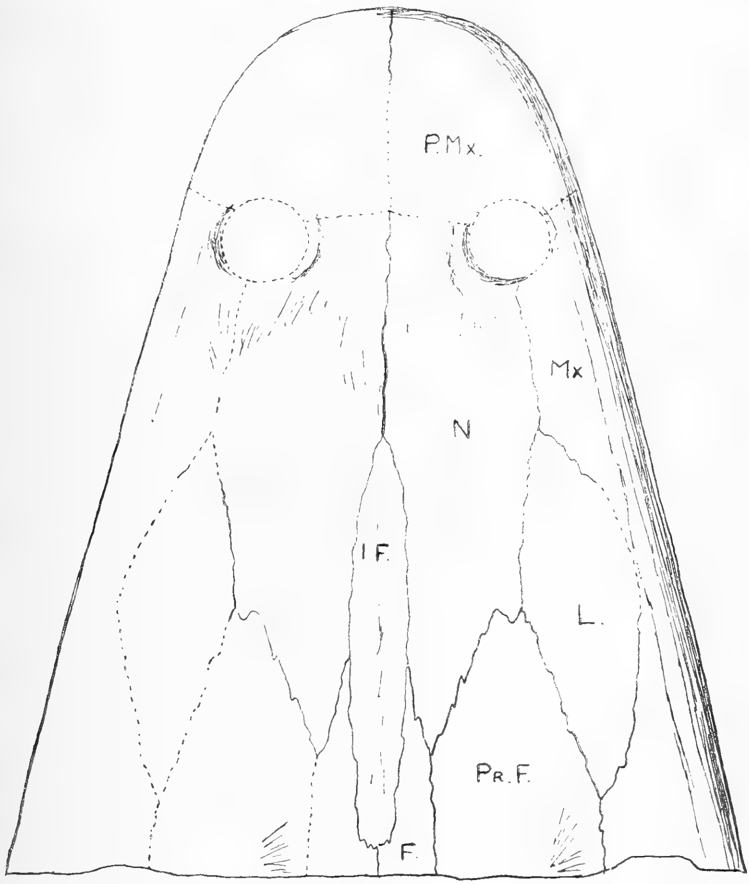
This new form is founded on a fairly complete large skull from the farm Harmonia, Senekal District, Orange Free State. It differs from the species of *Capitosaurus* in its greater elongation; but in the essential structure of the brain-region it agrees so closely with the generic features of *Capitosaurus* that it must undoubtedly be placed close to that genus in the family Capitosauridae.

The skull was found lying in a weathered condition, palate upwards, on a band of fine sandstone at the base of the Upper Beaufort Beds, not far above the horizon at Senekal which yielded *Rhinesuchus senekalensis*. The orbital portion was lost, but the anterior and posterior portions were collected; and, on the assumption that the outer line of the skull was regular, it has been possible to restore the outline. The fossil was first brought to our notice by Professor T. J. Dreyer, of Bloemfontein, in whose honour I have named the species.

The chief features of the dorsal surface of the snout are that the nostrils are small, rounded, and wholly on top of the snout, the large size of the nasals, and the presence of a narrow elongate interfrontal. A similar bone is seen in *Eryops* and in *Trematosuchus sobeyi*, and possibly occurs in other forms. Wiman (1916) considered that the bone was homologous with the Mesethmoid of Fishes; and Broili (1917) says that the inter-naso-frontal or naso-frontal, as he calls the bone, cannot be other than an ethmoidal. It should be noted in this connection that neither in this skull nor in that of *Trematosuchus sobeyi*, where the bone is also seen in cross-section, is there any irregularity in the ventral surface of the bone—no median ridge or channel appears, but the surface is quite smooth like that of the surrounding bones. Watson has given cogent reasons for refusing to accept those azygous elements as cartilage bones or ethmoid elements.

The orbits are not seen. The lachrymal does not touch either the orbits or the nostrils. The frontals are narrow.

The anterior palatal vacuities are separate, not coalesced. The palatine forms the posterior border of the internal naris. It carries

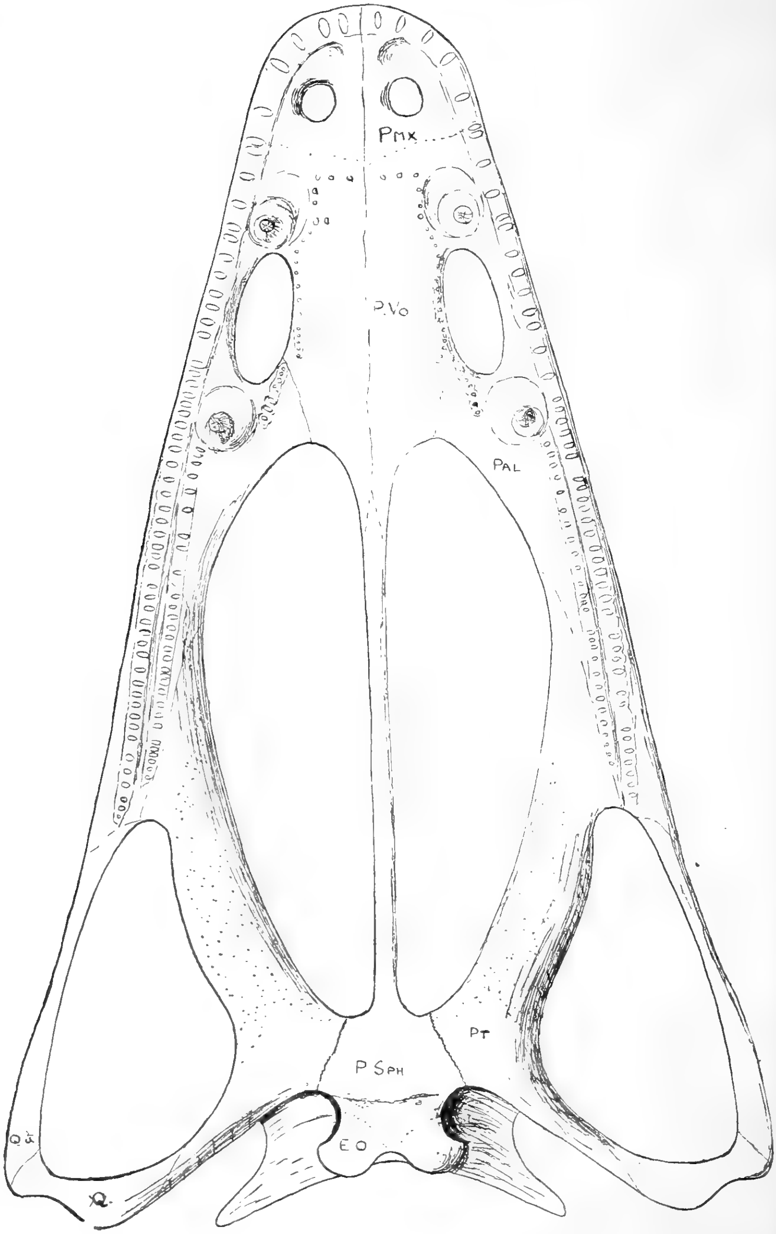


Text-fig. 11.—*Kestrosaurus dreyeri*, gen. et sp. nov. Dorsal view of snout of type.

a large tusk behind the naris, a row of medium-sized teeth, similar to the maxillary teeth and parallel to them, and a short row of teeth mesial to the tusk.

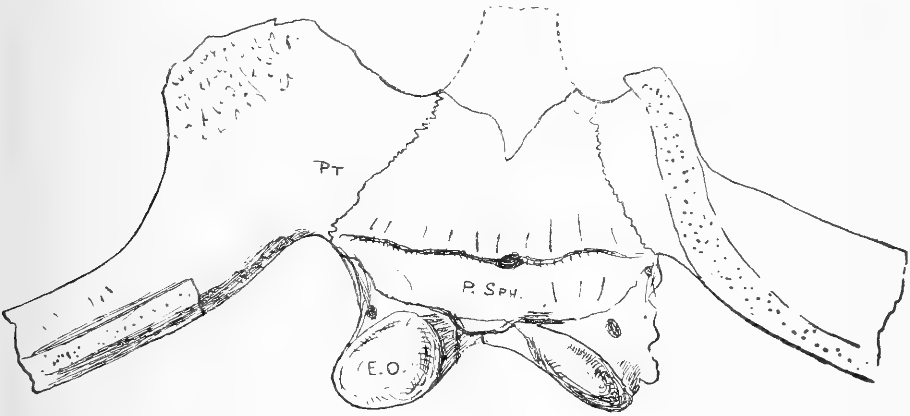
The prevomer carries a large tusk in front of the naris, a longitudinal row of teeth bordering the naris, and a transverse row between the tusks of opposite sides.

The anterior wing of the pterygoid is rugose.

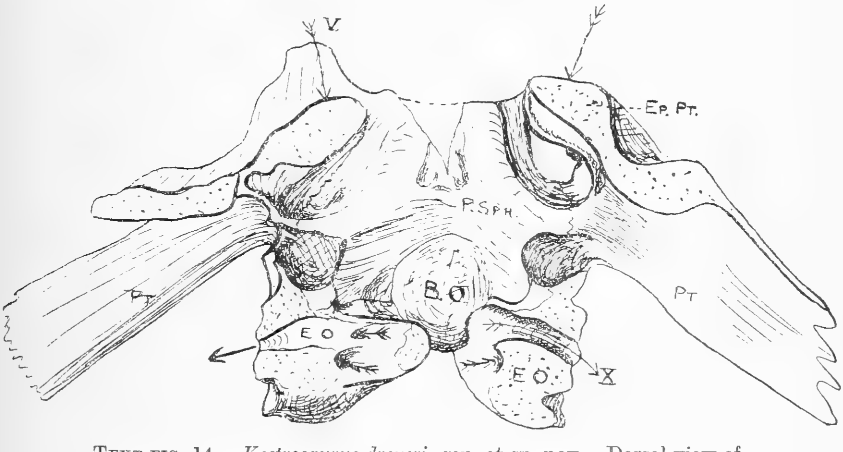


TEXT-FIG. 12.—*Kestrosaurus dreyeri*, gen. et sp. nov. Restoration of palate of type.

Parasphenoid.—The anterior stem of the parasphenoid is not well preserved, but it was undoubtedly long and narrow. The posterior portion of the bone is plate-like, widest posteriorly and articulates on



TEXT-FIG. 13.—*Kestrosaurus dreyeri*, gen. et sp. nov. Ventral view of bones of basicranium.



TEXT-FIG. 14.—*Kestrosaurus dreyeri*, gen. et sp. nov. Dorsal view of basicranium of type.

either side with the pterygoid by a deeply interlocking suture. The under surface is slightly hollowed out. Across the bone lies a prominent transverse ridge running between the ends of the pterygoidal sutures. Near the middle of this ridge two small nutritive foramina pass forward into the bone. The hinder end of the bone is free in

the middle and articulates with the exoccipitals in its outer thirds. The upper surface is well displayed. From behind the processus cultriformis two broad rounded ridges curve backwards, outwards, and upwards to form a slight protuberance above the front wall of the inner vestibule of the ear. Outside these ridges the bone slopes rapidly down to meet the pterygoid, so that on each side there is a curving, fairly deep and broad canal which opened forward by a large foramen for the exit of the branches of the Vth nerve. The outer posterior wall of this groove is formed by the pterygoid ; and internal to this the parasphenoid must have articulated with the pro-otic, which is not preserved.

The parasphenoid forms the inner margin of the internal vestibule of the ear. Between these circular excavations the bone is deeply hollowed for the reception of the basioccipital.

Basioccipital.—This is a small, roughly circular ossification lying on the hollowed dorsal surface of the parasphenoid. It is thickest posteriorly and thins to a flange anteriorly. It is visible from behind, lying between the parasphenoid and the bridge of bone joining the exoccipitals which forms the floor of the foramen magnum.

Exoccipital.—The exoccipital condyle is convex, with a marked lateral and ventral ridged edge. In outer view, the bone passes forward to meet the pterygoid in a vertical suture, the bone forming the lower border of the fenestra ovalis. The suture with the parasphenoid is almost horizontal externally. Seen from above, the exoccipital forms the outer and most of the posterior walls of the vestibule, forming with the parasphenoid a comparatively thin wall of bone separating it from the deep recess in which the basioccipital lies. Traversing the vertical process of the bone which forms the side of the foramen magnum is the large passage for the Xth nerve, and a smaller tunnel for the hypoglossal nerve. Internally the wall of the brain-case is furnished with a small pit beneath the internal opening for nerve X.

The exoccipital meets its neighbour by a bridge of bone which lies above the basioccipital and forms the floor to the foramen magnum. The vertical process of the bone is divided into two wings, the outer meeting the tabular and the inner the dermosupra-occipital. The inner is not expanded as in *Capitosaurus* sp., Watson, and is shorter than in that form.

Paroccipital.—There is a small bone which lies on the exoccipital behind the passage for the Xth nerve and behind the fenestra ovalis. Its outer upper corner meets the tabular.

Basisphenoid.—It seems to be uncertain whether the basisphenoid is or is not completely ossified. Lying below the epipterygoid in the channel between that bone and the ridge on the dorsal surface of the parasphenoid is a rounded ossification which may be the basisphenoid. It is in contact with the lower inner surface of the epipterygoid.

Pterygoid.—This is similar to that of *Capitosaurus* sp., Watson.

Epipterygoid.—Only the basal portion of this bone is preserved. It lies on the outer edge of the anterior end of the quadrate ramus of the pterygoid, is thin laterally and thickens internally and above. Its posterior portion is thin, vertical, and concave from without; its anterior portion—when viewed from in front—is triangular in section as preserved, the outer face sloping inwards and upwards to give rise to the ascending process. The base of the triangle lies on the upper surface of the pterygoid and the outer edge of the parasphenoid, between it and the lower bones being a large foramen which lies externally to the lateral channel on the upper surface of the parasphenoid. This must be the foramen for the vena capitis lateralis.

Quadrate.—This has a large exposure on the posterior surface. The quadrate foramen is fairly small and low down, and lies on the suture between the quadrate and quadratojugal. The inner surface of the bone is overlapped by the pterygoid, which reaches back almost to the articular surface and which has a long articulation with the squamosal.

The complete absence of the paroccipital in the occipital view places this skull among the Stereospondyls. The relations with *Capitosaurus* sp. are seen to be as follows:—

1. The basioccipital is equally well ossified, and takes no part in the formation of the condyles.

2. The basisphenoid is less well ossified. Indeed, it may be doubtful if a bony basisphenoid be present, unless the cartilaginous bone mentioned as lying on the right of the dorsal surface of the parasphenoid be one of the paired ossifications seen in *Capitosaurus* sp.

3. The exoccipital articulates with the pterygoid and excludes the parasphenoid from the border of the fenestra ovalis; but the exoccipital-pterygoid suture is not visible in ventral view.

4. There is no ossified supraoccipital and, further, there is no step on the margin of the exoccipital, suggesting that the supra-occipital cartilage had disappeared.

5. The paroccipital is a very small bone; the pro-otic is not preserved—but the supports for it are comparatively thin walls of bone, so that it was probably reduced.

6. The ventral end of the epipterygoid is expanded and the bone must have had a large ascending process as well as an otic process.

In these features the form shows a slight advance on *Capitosaurus*, and it is also somewhat specialised in the elongation of the snout. It is probable, however, that its horizon is slightly lower than that of the skull described by Watson.

Type.—Incomplete skull, S.A.M., Cat. No. 3452.

Locality.—Harmonia, Senekal, Orange Free State.

Horizon.—Upper Beaufort Beds. Probably *Procolophon* zone.

Gen. CYCLOTOSAURUS, Fraas.

1889. Fraas, Palaeontographica, vol. xxxvi.

Similar to *Capitosaurus*, but the otic notch closed, and the exoccipital has a fairly long suture with the pterygoid.

Cyclotosaurus albertyni, Broom.

1904. Broom, Rec. Albany Mus., vol. i, p. 178.

A large, imperfectly known species, founded on a very fragmentary skull.

Type.—Imperfect skull. S.A.M., Cat. No. 1876.

Locality.—Near Rouxville, Orange Free State.

Horizon.—Upper Beaufort Beds. *Cynognathus* zone.

Fam. RHYTIDOSTEIDAE, von Huene.

1920. von Huene, Acta Zoologica, p. 458.

Gen. RHYTIDOSTEUS, Owen.

1884. Owen, Quart. Journ. Geol. Soc., vol. xl, p. 333.

Medium-sized skull with orbits placed laterally. Nostrils also lateral and far behind the point of snout. Basicranial region incompletely known ; exoccipital has long suture with the pterygoid.

Rhytidosteus capensis, Owen.

1884. Owen, *loc. cit.*, p. 333, pls. xvi, xvii.
1919. Watson, Phil. Trans., B, 209, p. 35, fig. 21.
1920. von Huene, Acta Zoologica, p. 458, fig. 14.

The type species. Characters as for genus.

Type.—Imperfect skull in the British Museum (No. 455).
Locality.—Beersheba, Orange Free State.
Horizon.—Upper Beaufort Beds. ? *Cynognathus* zone.

Fam. Trematosauridae, Watson.

1919. Watson, Phil. Trans., B, 209, p. 67.

" Stereospondyls with relatively high skulls with narrow elongated snouts. Orbits of small or medium size, placed laterally. Processus cultriformis of the parasphenoid very narrow. Posterior end of the parasphenoid carried very far back and with the pterygoid forming a floor to the middle ear region." (Watson.)

Gen. TREMATOSAURUS, Braun.

1849. Burmeister, Die Labyrinthodonten aus dem bunten Sandstein von Bernberg, Abth. i, p. 1.

Characters as for family.

Trematosaurus kannemeyeri, Broom.

1909. Broom, Ann. S. Afr. Mus., vol. vii, pt 3, p. 270.
1920. " ? *Aphaneramma*," von Huene, Acta Zoologica, p. 446, fig. 8.

The original description reads as follows :—

" The type of this new species is the centre part of a skull received from Dr. Kannemeyer and obtained by him in the Orange River Colony. Posteriorly it is broken obliquely across a little behind the orbits, and in front is broken through about 65 mm. in front of the orbits.

" The skull is evidently that of an animal about twice the size of *Trematosaurus brauni*, and it has probably differed from the type species in having the snout relatively longer.

" The orbit measures 31 mm. by 20 mm., and the interorbital measurement is 49 mm. At the back of the orbit the width of the skull is 94 mm., and at transverse plane 60 mm. ; in front of the orbit 64 mm.

" The surface of few of the bones is preserved, but where it is found it is seen to be pitted as in *T. brauni*, and a groove runs up the snout and passes along nearer to the middle line than to the orbit.

" The frontal does not enter the orbital margin, and passes much further forward than in *T. brauni*, the anterior end being in advance of the portion preserved.

"The prefrontal is large, and ends about 55 mm. in front of the orbit.

"The postfrontal is long and narrow, and, so far as preserved, fairly similar to that figured by Burmeister in *T. brauni.*

"The postorbital is peculiar. It forms 9 mm. of the orbital margin, but behind the orbit it becomes rapidly constricted till it measures only 4 mm. across, and then slowly widens out till it measures 13 mm. The preserved portion measures 43 mm. in length, and probably at least 10 mm. are missing.

"The maxillary teeth are not well preserved. Where preserved they are small and uniform, and eight occupy 11 mm.

"The parasphenoid (vomer) is very narrow.

"The resemblance of this South African form to *Trematosaurus brauni* are sufficiently great to leave little doubt that both should be placed in the same genus. The Spitzbergen Labyrinthodont recently described by Smith Woodward as *Aphaneramma rostratum* has an elongated snout, but is not allied to the South African form."

Von Huene considers, however, that the two forms are closely allied.

Type.—Middle portion of skull (S.A.M., Cat. No. 1329).

Locality.—Orange Free State.

Horizon.—? Upper Beaufort Beds.

Gen. TREMATOSUCHUS, Watson.

1919. Watson, Phil. Trans., B, 209, p. 41.

Trematosuchus sobeyi (Haughton).

1915. *Trematosaurus sobeyi*, Haughton, Ann. S. Afr. Mus., vol. xii, pt. 2, p. 47, fig. 6, pls. viii, ix.

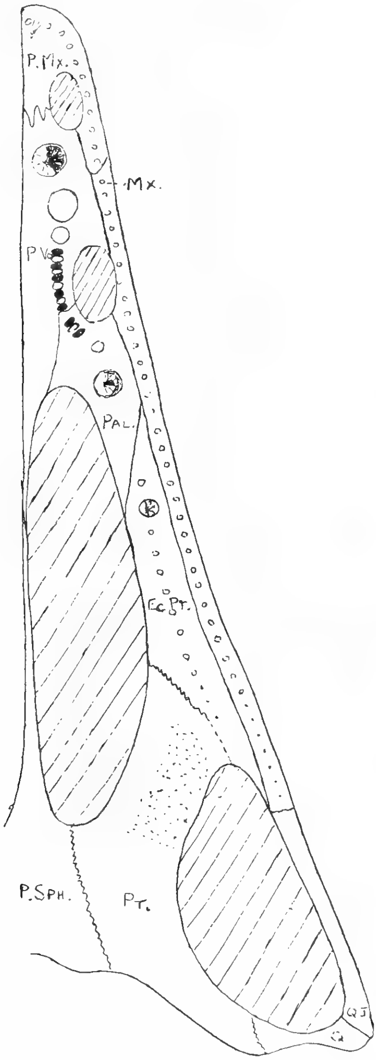
1919. Watson, *loc. cit.*, p. 41.

1920. *Trematosaurus sobeyi*, von Huene, Acta Zoologica, p. 443.

The type of this species was described in 1915. Watson says: "*T. sobeyi* does not belong to *Trematosaurus*, differing in having no anterior palatal vacuities between the premaxilla and prevomers, in lacking the corresponding perforations of the dorsal surface of the premaxillae and in the distribution of the palatine and ectopterygoid teeth."

Re-examination and further development of the extreme front of the palate show that the original description was incomplete and therefore misleading. The South African form possesses an anterior

palatal vacuity placed exactly as in *Trematosaurus brauni, i.e.* bounded on the outside and in front by the premaxilla and behind



TEXT-FIG. 15.—*Trematosuchus sobeyi* (Htn.). Left side of palate of type.

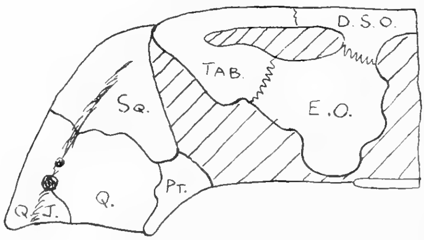
by the prevomer. Reference to the photograph published with the original description will show that the premaxillae are very thin in their dorsal portions, the bone on the left side having been lost in

front of the nostril. While the bone is not actually perforated when perfect, its under surface is concave and the bone very thin.

It is probable that the suture between the pterygoid and ectopterygoid is as in *T. brauni*, and not as originally figured by me.

The distribution of the palatal teeth differs very slightly in the two forms, while in *Trematosuchus* the palatine is smaller in relation to the ectopterygoid than in *Trematosaurus*, the suture between the bones being longitudinal in the South African form, and not transverse. In this connection, however, it should be noted that the suture in Watson's figure of *T. brauni* is dotted, being apparently a doubtful one.

The occiput as far as it is preserved agrees with that of *T. brauni*. The condyles are broken off, but they were obviously paired. The



Text-fig. 16.—*Trematosuchus sobeyi* (Htn.). Left side of occipital aspect of type.

quadrate, however, is a larger bone in the South African form, and the posterior portion of the squamosal correspondingly smaller.

While accepting Watson's change in nomenclature, it should be noted that most of the reasons advanced by him fall away, and that the differences between the two genera are very small. In nearly all essential details the two forms agree closely, and there can be no doubt that the two are closely allied. The South African form is, of course, considerably larger than *Trematosaurus*.

A portion of a small skull from the type locality (S.A.M., Cat. No. 5136) is probably part of a small member of the species. It is an incomplete postorbital section, which shows among other things the right quadrate region. Here the quadrate is seen to pass up a considerable distance in front of the occipital part of the squamosal, the latter covering most of the quadrate in occipital view. The inner edge of the quadrate articulates with the pterygoid. An interesting feature is that in this apparently immature specimen neither the ectopterygoid nor the adjacent part of the maxilla carry teeth. The anterior ramus of the pterygoid is faintly rugose in its middle part.

The bones of the surface of the skull, as far as they are preserved, agree with those of the type; the suture between the parietals is open; those between the other bones much more closed. The frontals had dropped out before fossilisation.

Type.—Skull (S.A.M., Cat. No. 2779).

Locality.—Sobey's Quarries, Queenstown, C.P.

Horizon.—Upper Beaufort Beds. *Cynognathus* zone.

Gen. MICROPOSAURUS, gen. nov.

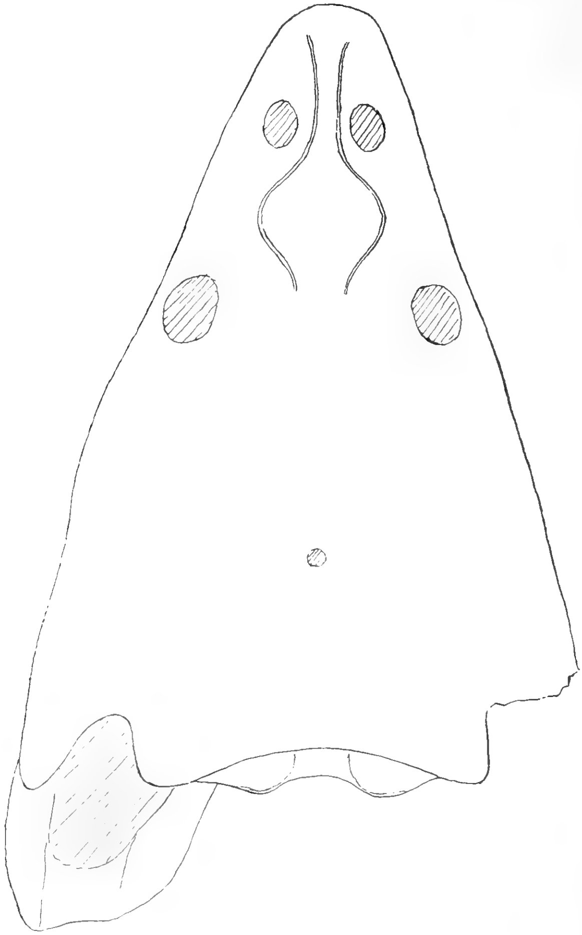
Microposaurus casei, sp. nov.

The skull which forms the type of this genus and species was discovered by Dr. E. C. Case and the writer in 1923 during an examination of the exposures just above the Wonderboom Bridge, south of Burghersdorp, and is thus from the *Cynognathus* zone. The skull was embedded palate upwards, in a fairly soft dark-green shaly mudstone. The bone, however, is coated with a thin layer of very hard ferruginous material—almost pure hematite—which it has been found impossible to separate from the rugose upper surface of the skull. Consequently it has not proved possible to trace sutures, and the following description is therefore very incomplete. Nevertheless, the general features of the skull are sufficiently distinct to justify one in naming it.

The skull is triangular in shape, longer than broad, with straight sides. The snout is rounded. The nostrils are not terminal, not lateral, and fairly close together. The orbits are small, lateral, and wholly in the anterior half of the skull. The otic notches are small. The quadrate is considerably posterior to the occipital condyles, although this feature may have been accentuated by post-mortem crushing.

The premaxillary and maxillary teeth are of more or less uniform size, the two anterior being larger than the others. The palate carries several large tusks. On the right-hand side two tusks occur in front of the internal naris; on the left the hinder of the two alone is preserved. Internal to each choanal opening is a bowed ridge carrying a number of fairly small teeth. On the left-hand side two large tusks are carried by the palatine, behind the internal naris; on the right only one tusk is present. What is presumably the ectopterygoid bears a row of teeth which decrease in size posteriorly. The anterior lateral wings of the pterygoids carry a number of denticles; but neither the prevomer nor the parasphenoid seem to do so.

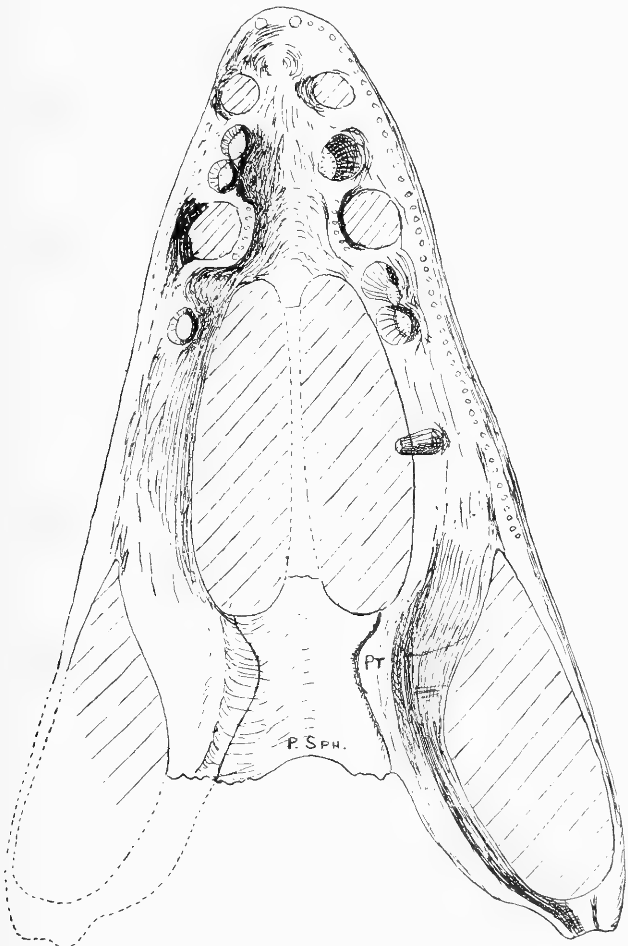
The processus cultriformis of the parasphenoid is long and narrow, broadening posteriorly. As in *Trematosaurus*, the parasphenoid has a free posterior end, where it is a broad, fairly thick plate of bone with a



TEXT-FIG. 17.—*Microposaurus casei*, gen. et sp. nov. Outline of dorsal view of type.

ventral surface which is concave from side to side and convex from back to front. It has an arcuate suture with the pterygoid on each side. Laterally it supports the exoccipital; and—save for the possible presence of a small basioccipital lying on its dorsal surface—it forms the floor of the brain-case.

The exoccipital forms a large rounded condyle. It is not visible in ventral view, but that fact may be due to crushing of the skull. The inner face of the quadrate ramus of the pterygoid is slightly chan-



TEXT-FIG. 18.—*Microposaurus casei*, gen. et sp. nov. Palatal view of type.

nelled; and between it and the exoccipital the large fenestra ovalis runs forward into the brain. The floor of this opening is mostly formed by the pterygoid, as in *Trematosaurus brauni*. The exoccipital is pierced above this fossa—at the place where it turns outwards to form the lateral wing of the bone—by a small foramen opening into a straight canal which leads forwards and inwards.

The quadrate process of the pterygoid is very long, so that the quadrate lies considerably behind the plane of the condyles. There is a fairly large quadrate foramen.

The epipterygoid is a broad plate of bone articulating with the pterygoid in advance of the condylar plane. Owing to the crushing of the skull it is flattened downwards. Its upper end is missing.

The bones of the brain-case have become displaced by shattering, and "stringers" of very hard ferruginous matrix pierce the bones in varying directions. I have not been able to delimit the various bones of the otic region, nor to determine satisfactorily whether or not a basioccipital is present.

The chief measurements are as follows :—

Greatest length	435	mm.
Greatest width	260	,,
Tip of snout to back of condyles	350	,,
Snout to plane of front of nostril	40	,,
Length of nostril	36	,,
Internasal width	20	,,
Preorbital length in median line	125	,,
Interorbital width	82	,,

Type.—Somewhat crushed skull (S.A.M., Cat. No. 6556).
Locality.—Wonderboom, S. of Burghersdorp, C.P.
Horizon.—Upper Beaufort Beds. *Cynognathus* zone.

Fam. Brachyopidae, Broom.

1915. Broom, P.Z.S., p. 366.
1919. Watson, Phil. Trans., B, 209, p. 68.

"Stereospondyls with short parabolic skulls, orbits of medium or large size placed anteriorly. Pterygoids turned downwards at the sides so that the palate is trough-shaped." (Watson.)

Gen. batrachosuchus, Broom.

1903. Broom, Geol. Mag., N.S., Dec. iv, vol. x, p. 499.
1919. Watson, Phil. Trans., B, 209, p. 44.

Batrachosuchus browni, Broom.

1903. Broom, *loc. cit.*, p. 499.

The type is a beautifully preserved skull lacking the maxillary and premaxillary borders. The sutures of the top of the skull are all

displayed save in the nasal region. The median length of the top of the skull is 200 mm.; the maximum length 250 mm.; and the greatest width 250 mm. The interorbital width is 87 mm.

The chief features of the genus have been noted by Watson. The orbits are wholly in the anterior half of the top of the head, and are widely separated.

The nasals are fairly small, but form the inner and posterior borders of the nostrils. Posteriorly they articulate with the prefrontals, frontals, and with a small median element, the interfrontal. The latter is diamond-shaped and lies between the nasals and frontals. The frontal is excluded from the orbital border. The parietals are larger than the frontals. The suprasquamosals are large; the portions of the tabularia and dermosupra-occipitals occurring on the roof are small.

The palatal and occipital features displayed agree almost entirely with those described by Watson for his *Batrachosuchus* sp. A slight difference exists, however, in that in *B. browni* the parasphenoid does not extend to the back of the skull between the condyles, but stops short of the posterior border, a plate of exoccipital about 10 mm. broad lying between the condyles behind the parasphenoid. The ventral surface of the parasphenoidal plate is sculptured like the top of the skull, but more lightly.

Type.—Skull (S.A.M., Cat. No. 5868).

Locality.—Aliwal North, C.P.

Horizon.—Upper Beaufort Beds. *Cynognathus* zone.

Batrachosuchus sp., Watson.

1919. Watson, *loc. cit.*, p. 44, figs. 27, 28, pl. i.

This skull, now in the British Museum—from an unknown locality,—differs from the type of *B. browni* in having a maximum width greater than the basal length. Further, there is apparently no interfrontal, and the parasphenoid passes further back. It certainly seems to indicate another species, and the suggestion is made that the form be known as *Batrachosuchus watsoni*, sp. nov.

Grade INCERT ?.

Gen. PHRYNOSUCHUS, Broom.

1913. Broom, Ann. S. Afr. Mus., vol. xii, pt. 1, p. 6.

Phrynosuchus whaitsi, Broom.

1913. Broom, *loc. cit.*, text-fig. 1.

Original description : " The specimen consists of much of the skull in a very weathered condition, remains of most of the vertebrae and short ribs as far as the pelvic region, the most of the right front and hind limbs, and considerable indications of the dermal covering. Allowing for a moderate tail, the whole animal measured about 350 mm.

" The skull shows the impressions of most of the bones of the cranium, and is so broken across as to reveal the structure of at least the front half of the palate. The whole head is broad and very flat. The nostrils are wide apart, and the orbits, which are also far apart, are entirely in the anterior half of the skull.

" The nasal is probably very large, the prefrontal and lachrymal very small. Each frontal is broad, and shut out from the orbital margin by the meeting of the postfrontal with the prefrontal.

" The postfrontal is large and forms the greater part of the upper orbital margin. The postorbital is much smaller.

" The parietal is a large bone, with a small pineal foramen between the pair of bones. The squamosal is rather smaller than the parietal. Outside of the squamosal is a large quadratojugal.

" Behind the parietal is a large occipital.

" The parasphenoid (or vomer) is of large size and extends far forward as a broad flat plate. The prevomers are large and the internal nares far apart. The palatines are also large.

" The teeth are not well shown but are manifestly labyrinthodont. The length of the skull is about 68 mm., and the width almost exactly the same.

" Behind the occiput are some crushed bones which may be parts of the clavicles and interclavicle, and by the side of the neck are some small ossicles which may be the remains of gill arches.

" The body is long and salamander-like. The vertebrae are very imperfectly ossified and represented by paired ossifications, probably representing pleurocentra. The ribs are short as in the Branchiosauridae and almost straight.

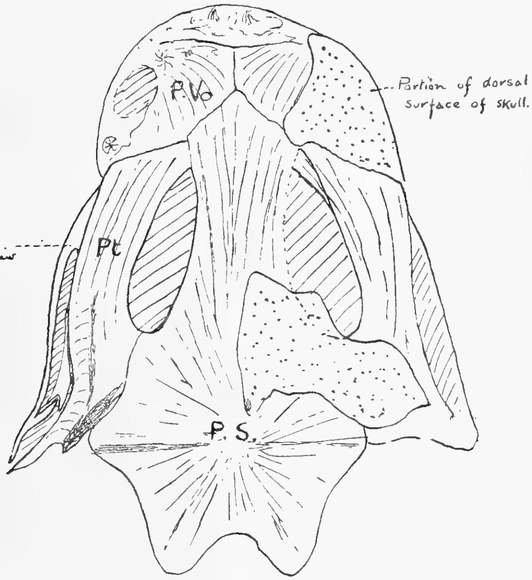
" The shoulder girdle and clavicular apparatus are not well preserved, but the humerus, radius, and ulna of the right side are seen. The humerus is a short bone, with a moderately wide distal end. The length is 16 mm., and the distal end is 9 mm. wide. The radius is a slender rod 10 mm. in length, and the ulna is rather stouter.

"Of the hind limb the only parts preserved are a portion of the tibia, five metatarsals, and two phalanges. There are certainly five digits, and the tarsus is unossified.

"There is a complete exoskeleton of thin, ossified scales."

Recently I have, without seriously damaging the specimen, exposed the dorsal surface of the palate of the type.

Parasphenoid.—The middle of the palatal side of the skull is occupied by a large bone, the anterior portion of which Broom recog-



TEXT-FIG. 19.—*Phrynosuchus whaitsi*, Broom. Dorsal view of palate of type.

nised as the parasphenoid. The posterior two-thirds of the bone is a pentagonal plate whose posterior edge is excavate and whose hinder lateral edges are slightly concave.

Anteriorly the plate is produced with a broad bar separating the interpterygoid vacuities. This bar expands slightly in front of the vacuities and is bluntly pointed, articulating with and partly separating the prevomers. The anterior lateral edges of the basal portion of the parasphenoid articulate with the pterygoids. The excavate hinder portion of the bones figured by Broom as "dermo-occipitals" is really part of the parasphenoid.

Pterygoid.—From its articulation with the parasphenoid the pterygoid sends forward a long broad curving flattened plate as an

anterior ramus, and a shorter, more slender, vertically placed posterior ramus. The former bounds the interpterygoid vacuity on its outer side and articulates in front with the prevomer; the latter passes back, presumably to the quadrate, and reaches the top of the skull.

The interpterygoid vacuities are fairly small and much longer than wide.

Prevomer.—The prevomers occupy most of the short wide section of the palate in front of the interpterygoid vacuities. They articulate posteriorly with the pterygoids and medially with each other and with the parasphenoid which overlaps on to them dorsally.

The internal nasal openings are wide apart, and their inner borders are formed by the prevomers. The prevomer carries a large tusk in front of the inner border of the internal naris.

No separate palatine can be distinguished in dorsal view. In *Nyrania*, which this form somewhat resembles, the palatine is figured as lying along the inner border of the interpterygoid vacuity; there is no evidence to show that it occupied that position in *Phrynosuchus*. The bone identified by Broom as " palatine " is presumably a part of the anterior ramus of the pterygoid.

The premaxilla lies in front of the prevomer and carries small teeth on its border.

It is probable that on the dorsal surface of the skull there was a small tabular projection on the posterior border.

The lower jaw is slender, and the dentary carries a row of pointed labyrinthodont teeth.

Type.—Incomplete skull and skeleton (S.A.M., Cat. No. 2357).

Locality.—Droogvoets, Fraserburg, C.P.

Horizon.—Lower Beaufort Beds. ? *Endothiodon* zone.

INDEX.

4. *Notes on some Cretaceous Fossils from Angola (Cephalopoda and Echinoidea).*—By S. H. HAUGHTON, B.A., D.Sc., F.G.S., Hon. Curator, Palaeontological Collections, South African Museum.

(With Plates XII–XV and Sketch-Map.)

THROUGH the kindness of Dr. L. Reinecke, the South African Museum became possessed of a set of the fossils collected by the field officers of the Companhia de Petroleo de Angola, and an attempt has been made by the present writer to identify the various species in the collection. As the Ammonoidea and Echinoidea of the Cretaceous deposits were considered to be the most important parts of the fauna these were examined in detail; and sufficient time has not yet been found to do more than give rough identifications of the Lamellibranchs and Gasteropods.

For assistance in the study of the Ammonites, thanks are due to Dr. L. F. Spath, who not only very kindly criticised the first draft of the manuscript, but examined some badly preserved doubtful Turonian forms. Thanks are also due to Dr. L. Reinecke for drawing the sketch-map reproduced with this paper.

The Ammonoidea were collected from the following localities:—

1. Camballa area, Cuvo River.
    Inflaticeras sp. aff. *gregoryi* Spath (800–1600 ft. above Upper Gypsum).
    Inflaticeras sp. (650–700 ft. above Upper Gypsum).
2. Coast, S. of Benguella Velha.

Phylloceras angolense sp. nov.	(1900 ft. above Upper Gypsum).
Mantelliceras sp.	,, ,,
Stoliczkaia dispar (d'Orb.)	,, ,,
Inflaticeras gregoryi Spath	,, ,,
Inflaticeras sp.	(1500 ft. above Upper Gypsum).
Prohysteroceras wordiei Spath	(1900 ft. ,,).
Anisoceras cf. *armatum* (Sow.)	,, ,,
Cf. *Torneutoceras virgulatum* (Brongn.)	,, ,,

3. East of Cabo Ledo ridge, Quissama.
   Inflaticeras sp.
   Inflaticeras spathi sp. nov.
   Anisoceras cf. *oldhamianum* Stol.
4. Cabo Ledo, Quissama.
   Inflaticeras sp. (800 ft. above Upper Gypsum).
   Elobiceras ? sp. „ „
   ? *Stoliczkaia dispar* (d'Orb.) (1000 ft. above Upper Gypsum).
   Oxytropidoceras sp. (800 „ „).
5. Foot of cliff, 2 km. E. of Cabo Ledo.
   Hysteroceras ? sp. juv.
   Other doubtfully Turonian forms.
6. 15 km. S. 75° E. of Capolo.
   Phylloceras surya (Forbes).
   Baculites sp.
7. On trail to Demba, near foot of hill, Muscima.
   Phylloceras surya (Forbes).
8. S. of river, Massangano.
   Placenticeras reineckei sp. nov.
9. Carimba or Maria Theresa.
   Nostoceras angolense sp. nov.
10. Localities near well-rig No. 1, Carimba.
    (*a*) Bunkhouse.
        Didymoceras sp. (35 m. below C bed, Teba).
    (*b*) 400 m. N., 100 m. E. of rig.
        Bostrychoceras polyplocum (Roemer) (35 m. below C bed, Teba).
    (*c*) 4200 m. N., 1750 m. W. of rig.
        Oxybeloceras binodosa sp. nov. (25 m. above F bed, Teba).
        Nostoceras angolense sp. nov. (25 m. above F bed, Teba).
    (*d*) 1450 m. W., 300 m. N. of rig.
        Libycoceras angolense sp. nov. (60 m. below C bed, Teba).
    (*e*) 2450 m. S., 250 m. E. of rig.
        Menuites macgowani sp. nov. (A bed, Teba).
    (*f*) 1350 m. W. 50° S. of rig.
        Libycoceras angolense sp. nov. (10 m. below A bed, Teba).
        Didymoceras hornbyense (Whiteaves) (10 m. below A bed, Teba).
        Oxybeloceras binodosa sp. nov. (10 m. below A bed, Teba).

(*g*) 2100 m. W., 1400 m. N. of rig.

Libycoceras angolense sp. nov. (40 m. below C bed, Teba).

(*h*) 1300 m. W., 250 m. S. of rig.

Oxybeloceras binodosa sp. nov. (35 m. below C bed, Teba).

Baculites subanceps sp. nov. (25 m. below C bed, Teba).

Localities 1–4 are thus seen to be characterised by one set of Ammonites, which may be called the "*Inflaticeras*—fauna," and the Carimba localities, 9 and 10 *a-h,* by an entirely different fauna in which turrilitiform and uncoiled Cephalopods play a predominating part.

The "*Inflaticeras*—fauna" is essentially similar to that described by Spath (Trans. Roy. Soc. Edinburgh, vol. liii, 1922, pp. 91 *et seq.*) from the Benguella area—which must not be confused with the region near Benguella Velha—although it is by no means so rich in forms as the more southerly fauna. Spath says that Gregory's "Angola fauna" probably corresponds with that of his Beds XI–XIII at Folkestone, *i.e.* near the top of the Upper Albian; he commented on Choffat's record of *Stoliczkaia dispar*, which is the zone fossil of the uppermost zone of the Albian, and which is a member of the *Inflaticeras*—fauna of Benguella Velha and Cabo Ledo. At the former locality it is said by Dr. Reinecke to occur at the same level as *Inflaticeras* spp.; at Cabo Ledo it occurs 200 ft. above *Inflaticeras* sp. and *Oxytropidoceras* sp. Thus the beds ranging between 650 ft. and 1900 ft. above the Upper Gypsum horizon may be definitely classed as Upper Albian.

It is interesting to note the occurrence of the Phylloceratid *Phylloceras angolense* with this fauna, as Spath draws attention to the absence of Phylloceratids and Lytoceratids from the more southerly localities in Angola.

The Carimba fauna is undoubtedly a Senonian one, characterised by the relative abundance of individuals of crawling and boring habit. The actual position of this fauna within the Senonian is not easily discernible. *Didymoceras hornbyense* is a Campanian form. *Bostrychoceras polyplocum* has been recorded both from the Trichinopoly group of India as well as from the Upper Senonian of N. Germany. *Libycoceras* is represented elsewhere by *L. ismaeli* of the Upper Senonian of Egypt. Until more detailed and extensive collecting is done in this very interesting Teba formation it would be hazardous to say whether Campanian fossils only are present or Lower Senonian zones are also represented.

The beds at the " foot of sea-cliff, E. of Cabo Ledo " have yielded a number of crushed Ammonites which show no sutures and little of the periphery. Dr. L. F. Spath has been good enough to examine the whole collection from this locality, and he reports as follows (in litt., 12th March 1924) : " Now I have the additional (but still doubtful) specimens, I think the Ammonites are Turonian *Prionocyclus*, or else entirely new. Schlüter's *A. neptuni of* pl. xi, especially the more involute figs. 3, 5, 7, 9, also his *A.* cf. *goupilianus* (which requires a new name) are comparable ' *Schloenbachia* ' ; perhaps also Petraschek's *Munericeras dresdense. A. neptuni* (Fritsch and Schloenbach) and *A. dentato-carinatus* (Roemer) are also similar, and among the ' *Schloenbachia* ' figured by Anderson (1902) from the Chico Formation you will recognise several allied forms. 6911, 6912, 6920 are almost certainly three distinct species, but it is a pity we do not know periphery and suture-lines."

Hitherto, Turonian Cephalopods have not been described from Angola, although they are known to occur in Nigeria. Choffat tentatively classed part of his " Calcaires coralliens blancs à *Actaeonella, Nerinea,* etc.," and his " Calcaire arénacé à *Inoceramus langi* " in the Turonian ; but he does not record Cephalopods from either of these sets of sediments, and the zonal position of the beds is doubtful. There are in the South African Museum a number of specimens of *Actaeonella anchietai* collected by Mr. W. J. Reynolds in the Dombe Grande area ; but they are, unfortunately, unaccompanied by Cephalopods. As to *Inoceramus langi,* Mr. Macgowan collected large specimens at several places near the Carimba well-rig in the Teba formation with *Nostoceras angolense* and *Oxybeloceras binodosa,* so that there can be no doubt that it is, at least in part, a Senonian form.

South of Benguella Velha (as is seen on Dr. Reinecke's MSS. sections) the *Inflaticeras* zone passes to within 250 ft. of the supposed base of the Teba formation, and this 250 ft. must comprise both the Cenomanian and Turonian beds, if such were deposited. In view of the absence of proved Cenomanian ammonites, and the doubtful occurrence of Turonian forms at one locality only, we are led to conclude that a non-sequence exists in the area, and that during Cenomanian and part of Turonian time at least no deposits were laid down at the southern end of the West African gulf of the Mediterranean sea. This regression of the sea was paralleled by the conditions in part of the Indo-Pacific area, for in Zululand there is a break between the Albian deposits and the Senonian.

The Echinoids were collected from the following localities (the numbers correspond to the localities given for the Ammonoidea).

1. *Epiaster catumbellensis* P. de Loriol (500 ft. above Upper Gypsum).
   Hemiaster reineckei sp. nov. (800–1500 ft. above Upper Gypsum).
   Cidaris malheiroi P. de Loriol (800–1600 ft. above Upper Gypsum).
   Orthopsis cf. *ruppelli* Desor (800–1600 ft. above Upper Gypsum).
2. *Epiaster catumbellensis* P. de Loriol.
   Isaster benguellensis P. de Loriol.
   Hemiaster reineckei sp. nov.
4. *Cardiaster kelleri* sp. nov. (800 ft. above Upper Gypsum).
11. 7 km. S. 65° E. of Capolo Guedes.
    Macropneustes sp. cf. *baylei* Coquand.

With the exception of the last, which is probably an Upper Eocene fossil, all the forms were associated in the field with ammonites of the *Inflaticeras*-fauna, and are therefore of Upper Albian age. *Epiaster catumbellensis*, *Isaster benguellensis*, and *Cidaris malheiroi* were recorded by Choffat from Benguella in his " Couches à Schloenbachia inflata " ; so that the association is common in Angola.

Stigmatopygus malheiroi from Choffat's " Calcaires coralliens blancs " has not yet been found in the northern part of the country ; but a specimen in the South African Museum, closely comparable with the figured type, was collected in association with *Epiaster catumbellensis* by Mr. W. J. Reynolds, at Dombe Grande. The species, therefore, may also be Upper Albian in age. There is apparently no evidence in any part of Angola of Cenomanian, Turonian, or Senonian Echinoids.

CEPHALOPODA.

Genus Phylloceras Suess.

Phylloceras angolense sp. nov.

This species is represented by a single specimen having the following dimensions: diameter 62 mm., thickness 23 mm. (0·37), height 36·5 mm. (0·59).

It differs from d'Orbigny's figure of *Ph. velledae* (Michelin) in that the umbilicus is larger, the costae are not sinuous, and the flanks do not approach one another so closely, being more subparallel, the

venter thus being more broadly rounded. It differs, too, from the Zululand specimen of *Ph. velledae* (Michelin) named by Spath in the nature of the costae, although it has a similar cross-section. The suture-line is not well seen. In the broadly rounded venter the form agrees more closely with *Ph. woodsi* v. Hoepen; but the ribbing is much finer and does not reach the umbilicus. No constrictions are seen. The umbilicus has not the sharp passage into the lateral surface seen in *Schluteria rousselli*. The form differs from *velledaeformis* (Schlüter) in that the ribs are radial and not forwardly inclined.

Type.—S.A.M., Cat. No. 6527.

Locality.—S. end of seacliffs, S. of Benguella Velha, Angola.

Horizon.—1900 ft. above Upper Gypsum band, with *Prohysteroceras wordiei* Spath.

Phylloceras surya Forbes.

1846. Forbes, Trans. Geol. Soc., vol. vii, 3, p. 106, pl. vii, fig. 10.

Two specimens are tentatively assigned to this species.

One (S.A.M., Cat. No. 6739) is a mould of one side of half of the last whorl of a peculiarly ornamented form. In the half-whorl there are 14 strong ribs, 8 of which reach the umbilicus, the others starting at various points between the umbilicus and the midpoint of the side of the shell. These ribs are slightly concave forward for a short distance from the umbilicus and are then slightly convex forwards. In addition there are the closely-set sharp ridges usually seen in this genus, which are separated by shallow broad grooves and die out towards the umbilicus. The latter is narrow and deep. Nothing is seen of the ventral surface nor of the suture-line. Dr. Spath has been good enough to inform me, from an inspection of a photograph, that the specimen is close to the type.

The other (6840) is a small internal cast having the dimensions: diameter 25 mm., thickness 8 mm. (0·32), height of last whorl 14 mm. (0·56), width of umbilicus 3·5 mm. (0·14). It possesses the same ornamentation of strong ribs with finer close costae. These cross the ventral surface.

Localities.—Muscima, on trail near foot of hill, Angola (6739); 15 miles S. 75° E. of Capolo, Angola (6840).

Genus Menuites Spath.

Menuites macgowani sp. nov.

Founded on a weathered specimen, chiefly internal cast, collected by Mr. J. Macgowan. The chief measurements are: height 153 mm.,

thickness 70 mm. (0·46), height of last whorl 70 mm. (0·46), diameter of umbilicus 35 mm. (0·23). The inner whorls show a line of lateral tubercles; there are eleven tubercles on the last whorl but one. On the last whorl is a development of a row of prominent spines on each side of the venter, each spine being borne at the end of a straight prominent rib which also carries the lateral spinose tubercle. The ribs do not appear to cross the venter. The suture-line is not preserved.

The species differs from the normal *Menuites* in that the last whorl is not broader than high. It is more globose than most of the described species of *Parapachydiscus*, but less globose than *P. koluturensis* (Stoliczka) or *P. fascicostatum* (Yabe). Ventral tubercles are figured by Stoliczka in a specimen of *P. egertoni* (Forbes), than which this form is more globose. The arrangement of ribs and tubercles is very similar to that of *Menuites auritocostatus* as figured by Schlüter.

Type.—S.A.M., Cat. No. 6742.

Locality.—2450 m. S., 250 m. E. of well-rig, Carimba, Angola.

Horizon.—A bed, Teba formation.

Genus Libycoceras Zittel.

Libycoceras angolense sp. nov.

This new species is represented in the collection by two shells and an external mould. It is compressed, keeled, and involute; the saddles are phylliform and entire as in *Indoceras* and *Libycoceras ismaeli* Zittel. The shell is thin, except along the keel and at the umbilicus. The ornamentation consists of fine, close sigmoidal ribs, bending backwards at the keel and disappearing on the dorsal half of the side. The ventral half of the side is furnished with elongate narrow low nodes, concave orad. On the old shell there are broad, low, untuberculate costae.

The youngest stage seen—diameter 1·5 mm.—has a broadly rounded venter. The sutures are not visible at this stage. In the next whorl the venter is still rounded, but is becoming sharper, and the whole whorl is flatter.

At a diameter of 14 mm. the shell is 3 mm. thick and has a whorl height of 7·5 mm. The ornamentation consists of closely-set fine waved growth-lines, with low elongate swellings along them in the outer third of the shell. Shell keeled with flattened sides to the venter. The suture-line is simple, the saddles being broad and entire, becoming narrower dorsally; the first and second lateral lobes show the beginning of a tripartite digitation, the others being entire.

At a whorl height of 13·5 mm., the thickness is about 11 mm., so that the ratio thickness : height of whorl increases rapidly.

The sides are flattened until the last half of the outer whorl, when they become distended and rounded. There is a row of umbilical tubercles and a row of indistinct tubercles bordering each side of the venter. The ribs are continuous across the ventral area. There is no row of median tubercles. The ribs are strong, curved slightly forward in the outer half, and sometimes bifurcate at the umbilical tubercle. The umbilicus is deep.

At a diameter of 46 mm. the saddles are still entire, while they decrease regularly in size from the third lateral to the umbilicus. The lobes are simply digitate, with the possible exception of those near the umbilicus.

At 70 mm. the third lateral saddle has become low and broad. The maximum number of saddles present is 10. The suture-line here is very like that of *Libycoceras ismaeli* Zittel as figured by Eck, save that the auxiliary saddles are fewer ; but Eck's figure is of a larger and older shell than ours, and in the old stage auxiliaries tend to increase in number.

The general shape and ornamentation is that of the Sphenodiscid genus *Indoceras* ; but it differs from that in its undivided first lateral saddle. From *Libycoceras ismaeli* it differs in its ornamentation, as *L. ismaeli* possesses, according to Pervinquière, ribs and a double row of tubercles. The unfigured and incompletely known *Libycoceras chargense* Blanckenhorn is distinguished by the absence of tubercles. From *Sphenodiscus* the form is separated by its entire saddles.

Co-types.—S.A.M., Cat. Nos. 6741 and 6891.

Localities.—1350 m. W. 50° S. of well rig, Carimba (6741).
2100 m. W., 1400 m. N. of No. 1 well, Carimba, Angola (6891).

Horizon.—6741. 10 m. below A bed, Teba formation.
6891. Limestone 40 m. below C bed, Teba formation.

Genus Stoliczkaia Neumayr.

Stoliczkaia dispar (d'Orbigny).

1840. *Ammonites dispar* d'Orbigny : Pal. fr., p. 142, pl. xlv. figs. 1–2.

Some badly preserved specimens are tentatively assigned to this species. In two of them tubercles occur on either side of the ventral surface ; in another, larger, specimen the strong rounded ribs run

across the venter and are untuberculate, the section of the periphery being thus rounded. The ribs are flexuous and variable in number. Umbilical tubercles are present. The suture-line is not seen.

Measurements of two specimens are as follows :—

Diameter	57 mm.	40 mm.
Height of last whorl . .	30 mm. (0·53)	20 mm. (0·50).
Thickness	15 mm. (0·26)	10·5 mm. (0·26).
Diameter of umbilicus .	11 mm. (0·19)	8 mm. (0·20).

Locality.—S. end of seacliffs, S. of Benguella Velha, Angola.

Horizon.—1900 ft. over Upper Gypsum horizon.

Genus PLACENTICERAS Meek.

Placenticeras reineckei sp. nov.

Founded on a single specimen, which seems to be sufficiently distinct from other described forms to merit a new specific designation.

The measurements are as follows : height 97 mm., height of last whorl 48 mm. (0·49), thickness of last whorl 30 mm. (0·30), height of umbilicus 14 mm. (0·15). These relations are very close to those of *P. tamulicum* (Blanford) as given by Kossmat. The suture-line differs in detail from that of *P. tamulicum.*

The shell has 7 umbilical tubercles and 32 elongated unpaired outer prominences bordering the flat and smooth ventral border on the last whorl. It is thinner than *P. subkaffrarium* Spath and has more ventral tubercles ; but belongs, like it, to the group of *syrtale*, and has the same lateral swellings.

No *Placenticeras* has hitherto been described from Angola. Pervinquière records *P.* (?) *uhligi* Choffat, *P. saadense* Th. and Peron, and *P. prudhommei* Peron from Tunis, whilst Peron has *P. saadense* Th. and Peron, *prudhommei* Peron, and *syrtale* (Morton) from Algeria. Dr. Spath informs me that " *P.*" *saadense* and " *P.*" *uhligi* belong to the genus *Knemiceras* and have no connection with *Placenticeras.*

Type.—S.A.M., Cat. No. 6523.

Locality.—S. of the river Massangano, Angola.

Horizon.—In or just above Limestone series.

Genus MANTELLICERAS Hyatt.

Mantelliceras sp.

A small weathered cast (Cat. No. 6728) can most probably be assigned to this Acanthoceratid genus. The dimensions are : dia-

meter 44 mm., thickness 21·5 mm. (0·49), height of last whorl 20 mm. (0·45), diameter of umbilicus 10 mm. (0·23). The form is thus thicker than *M. martimpreyi* (Coquand).

Genus Inflaticeras Stieler emend. Spath.

Inflaticeras gregoryi Spath.

1922. *Inflaticeras gregoryi* Spath, Trans. Roy. Soc. Edinburgh, vol. liii, 1, p. 127, pl. iii, figs. 1*a*, *b*, and footnote to p. 91.

Locality.—S. end of seacliffs, S. of Benguella Velha (6529).

Horizon.—1900 ft. over Upper Gypsum horizon.

Inflaticeras sp. aff. *gregoryi* Spath.

Locality.—Cuvo. On ridge E. of lagoon, Camballa village, Angola (6528).

Horizon.—Between 800 and 1600 ft. over Upper Gypsum horizon.

Inflaticeras spp.

There are several weathered fragments of whorls belonging to the *rostrata*-group and *evoluta*-group.

Localities.—6724. Benguella Velha, Angola.
6524, 6526. Grass-grown hill, E. side of Cabo Ledo ridge, Quissama, Angola.
6863. Ridge E. of Camballa village, N. of Cuvo River, Angola.
6902 and others, Cabo Ledo, Angola.

Horizons.—6724. 1500 ft. above Upper Gypsum horizon.
6524. Calunguembo formation.
6863. 650–700 ft. over Upper Gypsum horizon.
6902. 800 ft. over Upper Gypsum horizon.

Inflaticeras spathi sp. nov.

A weathered cast which is taken as the type of this new species has the following dimensions: diameter 33 mm., thickness 12 mm. (0·36), height of last whorl 12·2 mm. (0·37), width of umbilicus 13·5 mm. (0·41).

The sides of the outer whorl are ornamented with three tubercles—an umbilical tubercle, a lateral tubercle, and an outer node—like the younger whorls of *N. corruptus* (Stoliczka), and differs therein from *choffati* Spath, *inflatum* var. *spinosa* (Perv.) and *tectorium* (White). The ribs commence at the umbilicus, and are both single and bifurcate. The umbilical tubercle is at the bifurcation of the ribs where such takes place. The lateral tubercle is more than half-way to the venter. In the outer whorl there are 19 umbilical tubercles, and 26 outer nodes. The inner whorls do not show ornamentation.

Spath speaks of " a new and trituberculate form in the Ansorge collection " which seems, however, to differ from this in its less markedly costate condition. The prominence of the ribs in *I. spathi* leads to the form being considered an *Inflaticeras* of the *rostrata-munieri* type transitional to *Neokentroceras*.

Type.—S.A.M., Cat. No. 6530.

Locality.—Grass-grown hill, E. side Cabo Ledo ridge, Quissama.

Horizon.—" Calunguembo formation."

Genus Elobiceras Spath.

Elobiceras ? sp.

Locality.—6909. Cabo Ledo, Angola.

Horizon.—800 ft. over Upper Gypsum horizon.

Genus Prohysteroceras Spath.

Prohysteroceras wordiei Spath.

1922. Spath, Trans. Roy. Soc. Edinburgh, vol. liii, 1, p. 143, pl. iii, figs. 4*a-c*, 5, 6*a*, *b*.

A weathered cast whose inner whorls are not preserved seems referable to this species. Its dimensions are : diameter 110 mm., height of last whorl 35 mm. (0·32), thickness 27 mm. (0·25), umbilicus 48 mm. (0·44).

The specimen agrees fairly closely with the description of the type, except that there are only 54 ribs along the periphery of the last whorl instead of 70, and 34 at the umbilicus—thus bifurcation is less pronounced than in the type. In this feature the specimen seems to approach *P.* var. *compressa* of Spath. The whorl-section, too, is of slightly different shape from the type, the sides being more subparallel as in *P. decipiens*, Spath.

Locality.—S. end of sea-cliffs, S. of Benguella Velha, Angola (Cat. No. 6725).

Horizon.—1900 ft. over Upper Gypsum horizon.

Genus Hysteroceras Hyatt emend. Spath.

Hysteroceras ? sp. juv.

Among the material carrying the field-number R85 is a slab containing, among other things, a fragment of a small Ammonite showing the flank and ventral surface. The periphery is distinctly marked off by an obtuse ridge from the flank, and is keeled. On the flank the ribs are slightly sinuate, but on the periphery they bend strongly forwards and are distinctly separated from the keel by a shallow groove. Towards the peripheral border intercalary ribs appear on the flank and continue on to the periphery, so that in peripheral aspect the ribs are close-set. At the ridge separating the flank from the periphery the ribs are very faintly swollen.

The keel is not regular, but is slightly crenulate, formed of coalesced tubercles.

The shell, which is evidently a young one, has a diameter of about 7 mm. and a thickness about 2·5 mm.

Locality.—At foot of first sea-cliff, 2 km. E. of Cabo Ledo, Angola (Cat. No. 6737).

Horizon.—" Calunguembo formation."

Genus Anisoceras Pictet.

Anisoceras cf. *oldhamianum* Stoliczka.

1865. Stoliczka, Cret. Ceph. S. India, p. 175, pl. lxxxiii, figs. 1–4, pl. xcii, fig. 1.

A fragment 60 mm. long without test shows sutures similar to those figured by Stoliczka. There are badly defined tubercles and grooves on the siphonal side. The shell is almost circular in cross-section, 26 mm. by 29 mm. at the wider end.

Locality.—Grass-grown hill, E. side of Cabo Ledo ridge, Quissama (Cat. No. 6727).

Anisoceras cf. *armatum* (Sow.).

1818. *Hamites armatus*, Sowerby, Min. Conch., vol. ii, p. 153, pl. clxviii.

A number of specimens of a tuberculate Anisoceratid have four rows of tubercles—two lateral and two siphonal. Each set of tubercles

is on a strong rib which usually bifurcates between the siphonal tubercles and often splits between the lateral and siphonal tubercles of each side. In the largest specimen (diameter 26 mm.) the rib splits into three on the ventral surface. In most specimens there are strong intercalated untuberculate costae, sometimes one, sometimes two occurring between a pair of nodose ribs; but in the largest specimen all the ribs are tuberculate.

The costae do not pass across the dorsal surface; their place is taken by a series of much finer ribs, which are slightly convex forward.

The specimens thus differ from both *A. tropicalis* (Meunier) and *A. angolense* (Choffat) and seem to approach "*Hamites*" *armatus* (Sow.), one specimen being almost the counterpart of that figured by Bose in Bol. Inst. geol., Mexico, vol. xlii, 1923, pl. x, figs. 22–24.

Locality.—S. end of sea-cliffs, S. of Benguella Velha, Angola.

Horizon.—1900 ft. over Upper Gypsum horizon.

Genus Torneutoceras Hyatt.

Torneutoceras virgulatum (Brongn.).

(For literature, see 1922, Spath, Trans. Roy. Soc. Edinburgh, vol. liii, 1, p. 148.)

Among the specimens of *Anisoceras* cf. *armatum* (Sow.) is one specimen that is untuberculate, and has similar ornamentation to *Torneutoceras virgulatum* (Brongn.). Sutures, however, cannot be seen, and the identification, therefore, is doubtful.

Locality.—S. end of sea-cliffs, S. of Benguella Velha, Angola.

Horizon.—1900 ft. over Upper Gypsum horizon.

Genus Nostoceras Hyatt.

Nostoceras angolense sp. nov.

The specimen forming the type of this species consists of four whorls and a portion of the fifth. The last portion is free, but the remainder of the specimen is turrilitiform. Sutures are not visible. The coiling is dextral. The spirals are asymmetrical. There is a row of tubercles on either side of the siphon. The ribs are oblique, bent at the umbilical edge. Each pair of tubercles does not necessarily lie on the same rib; but between each pair of tuberculate costae are one or two ribs without tubercles.

The tubercles of the left side increase in importance as the shell grows, approaching nearer to the venter. The ribs do not bifurcate.

At about every half-whorl there is a transverse furrow bounded on either side by stronger ribs than the normal. Similar constrictions are shown by Schlüter in *Bostrychoceras* sp. nov. (sp. fide Spath) and in *B. pumicum* Pervinquière.

At a diameter of 10 mm. the whorl is impressed, so that it is probable that the young had not the open coiling of *Didymoceras* nor of *Exiteloceras*; nevertheless, the form can only be doubtfully assigned to *Nostoceras*. The maximum diameter of the coil is 35 mm.; the height of five coils 48 mm.

The costation approximates in fineness to that of *Didymoceras hornbyense* (Whiteaves), but the whorls are thicker than in that species, so that the shell is more acute, as acute as in *D. elongatum* (Whiteaves).

Nostoceras has not hitherto been recorded from Algeria, Tunis, Egypt, or Angola.

Type.—S.A.M., Cat. No. 6740.

Locality.—Maria Theresa or Carimba, Angola.

Horizon.—A bed, Teba formation.

Genus Didymoceras Hyatt.

Didymoceras hornbyense (Whiteaves).

1895. *Heteroceras hornbyense*, Whiteaves, Canad. Rec. of Sc., vol. vi, p. 316.

1903. „ „ „ Geol. Surv. Canada, Mesozoic Fossils, vol. i, 5, p. 332, pl. xlii, figs. 1–4.

A number of fragments in the collection are assigned to this species. One is a portion of a large whorl of a loosely coiled helicoid dextral spiral, showing no contact furrow. It has two rows of asymmetrically placed tubercles, with slightly oblique ribs continuing across the venter, but disappearing on the inner side of the whorl. On the lateral surface the ribs occasionally bifurcate at the tubercle; more usually they are single. The section is almost circular. The suture-line is not seen.

On other large fragments some of the ribs are single and continuous across the venter; but frequently two ribs coalesce at a tubercle—the bifurcated rim thus formed passing across the venter exactly as in Whiteaves' figures of *D. hornbyense*. The ribs are slightly flexuous.

In the younger whorl-fragments the bifurcation of the ribs is not

seen ; and in two fragments the flexuosity on the dorsal side is very marked.

Spath (Ann. Durban Mus., vol. iii, 2, p. 56) mentions having seen *D. hornbyense* from Barra do Dande, Angola.

Locality.—1350 m. W., 800 m. S. of well-rig, Carimba, Angola.

Horizon.—10 m. below A bed, Teba formation.

Didymoceras sp.

In one fragment (Cat. No. 6743) the tubercles are closer together and the ribs further apart than in *D. hornbyense,* and the ribs are not bifurcate.

Locality.—Bunkhouse, Carimba Camp, Angola.

Horizon.—35 m. below C bed, Teba formation.

Genus Diplomoceras Hyatt.

Diplomoceras ? cf. *indicum* (Forbes).

(For literature, see Woods, Ann. S. Afr. Mus., vol. iv, 7, 1906, p. 340.)

There is one specimen tentatively assigned to this species. The suture-line is not visible, and in its absence it is impossible to be certain of the identification.

The ribbing is simple, as in *D. ? indicum,* the costation becoming more oblique in the curved parts of the shell. The ribs are subequal, with the exception of the last one preserved, which is flared. At the extremity of each curve of the shell there is a single example of a bifurcating rib. The ribs continue on the inner margin of the shell, but are rather less marked there, and the intercostal spaces each carry two or three fine corrugations. The cross-section is nearly circular, with a maximum diameter of 6 mm. The diameter increases from 1·5 mm. to 6 mm. in a length of about 55 mm.

Locality.—" Map 65, D7 " (Cat. No. 6738).

Horizon.—Teba formation.

Genus Bostrychoceras Hyatt.

Bostrychoceras polyplocum (Roemer).

(For literature, see Boule, Lemoine, and Thevenin, 1907, Ann. de Paléont., vol. ii, p. 41.)

One slab of rock contains a good example of a dextral form showing six whorls ; and the same slab contains another whorl showing the

suture-line, which is very similar to that figured by Woods for the Pondoland form, which he called *Heteroceras* sp. (Ann. S. Afr. Mus.. vol. iv, 7, 1906, pl. xlii, fig. 5).

Locality.—400 m. N., 100 m. E. of well-rig, Carimba, Angola.

Horizon.—35 m. below C bed, Teba formation.

Genus Oxybeloceras Hyatt.

Oxybeloceras binodosa sp. nov.

There are several incomplete specimens of a Ptychoceratid with strong ribs which pass right round the shell, bent forward on the dorsal side in the larger limb, the ribs occurring on both limbs of the shell. Each rib carries two tubercles, one on each side of the siphonal area; the cross-section is circular. In addition to the nodose ribs the shell is ornamented with a series of fine growth-lines.

A specimen on slab 6877 shows that the young shell is not straight, but curved; while a very weathered fragment seems to indicate that the earliest stages had an Ancycloceratid coiling.

The ornamentation is similar to that of *O. crassum* of Colorado and to *Ptychoceras texanum*; also to that of *Didymoceras* sp. described from the same beds (see above); and in view of the fact that Whitfield has recorded *Heteroceras simplicostatum* as having a *Ptychoceras*-like early stage, we must bear in mind the possibility of this form described as *Oxybeloceras binodosa* being the young stage of a *Didymoceras*.

Localities.—6847, 6848. 1350 m. W., 800 m. S. of well-rig, Carimba, Angola.
6835. On limestone ridge 1300 m. W., 250 m. S. of well-rig, Carimba camp.
MVII. 4200 m. N., 1750 m. W. of rig, Carimba.
6877. "Map, 65, S.-E."

Horizons.—6847. 10 m. below A bed, Teba formation.
6835. 25 m. below C bed, Teba formation.
MVII. 25 m. above F bed, Teba formation.

Genus Baculites Lamarck.

Baculites subanceps sp. nov.

There are numerous examples of a large form which is assigned to a new species. The cross-section is oval, the siphonal side being narrower than the antisiphonal. The shell tapers gradually. The

body-chamber is long—the diameter at the smaller end of the chamber is 24 mm. by 18 mm. The ornamentation is similar to that of the *anceps*-group—swollen nodes on the sides near the dorsal edge, with not very prominent forwardly directed ribs which bend backwards to pass across the venter with a slight convexity forwards. Internal casts of the larger specimens show a shallow longitudinal groove along each side of the venter and a flattening of the venter as in *B. vagina* Forbes. The lateral nodes are, however, more dorsally situated than in *B. vagina* as figured by Kossmat, and there are no ventral tubercles. The suture-line differs slightly from that of *B. anceps* Lamarck as figured by d'Orbigny, but is of the same general form. It is less minutely frilled than that of *vagina* var. *otacodensis* Kossmat. There is no siphonal keel.

Locality.—On limestone ridge 1300 m. W., 250 m. S. of well-rig, Carimba, Angola.

Horizon.—25 m. below C bed, Teba formation.

Baculites sp.

There are, in the collection, some fragments of an untuberculate form of *Baculites.* The only ornamentation at a diameter of 17·5 mm. is a series of very fine growth-lines, bent strongly forward on the ventral half of the shell. The section is ovoid, the ventral side being more sharply rounded than the dorsal, with a suggestion of a shallow groove on each side of the siphonal edge in the larger specimens. The suture-line is not distinctly seen.

This form is possibly comparable with *Baculites gracilis* Shumard, which is recorded by Solger from the Cameroons, and by Boule, Lemoine, and Thevenin from the M. Cenomanian of Madagascar.

Locality.—15 miles S. 75° E. of Capolo, Angola (Nos. 6744, 6745).

Horizon.—In white round-weathering boulders lying in marl, 1200-1500 ft. below Teba formation.

ECHINOIDEA.

Genus Cardiaster Edw.

Cardiaster kelleri sp. nov.

This new species is represented by six crushed and somewhat weathered specimens, and is but tentatively assigned to this genus as no distinct fasciole has been seen.

The largest and most symmetrical specimen is 58 mm. long and 59 mm. broad, and had a height of probably 43 mm. The greatest breadth is in the plane of the apical disc. The summit is in advance of the apical disc, but otherwise the profile is generally similar to that of *Holaster meslei* as figured by Fourtau.

Anterior ambulacrum in a well-marked groove with strong borders; poriferous zones composed of pairs of obliquely placed small pores of which the outer is round and the inner bowed and slightly elongate.

Anterior paired ambulacra nearly in the same straight line. Pores unequal; anterior zone narrower than the posterior zone. In anterior zone outer row of pores rounded, other row horizontal and slightly elongate. In posterior zone, both rows elongate.

Posterior paired ambulacra have poriferous zones almost similar to one another.

Ornamentation not preserved, except for small patches of small tubercles near the periphery.

This form differs in profile from the incomplete specimen figured by de Loriol as *Holaster dombeensis* and approximates to that of *Cardiaster bicarinatus*, from which it differs in being narrower and in not possessing the posterior median keel.

Types.—S.A.M., Cat. No. 6890 *a-f.*

Locality.—Cabo Ledo, Angola; probably about 800 ft. above Upper Gypsum horizon. Collected by A. P. Keller.

Genus Epiaster D'Orb.

Epiaster catumbellensis P. de Loriol.

1888. P. de Loriol, Arch. des Sc. Bibl. Univ., 3e per., t. 19, No. 1, Geologie d'Angola, p. 5.

1888. P. de Loriol, Mém. Soc. de Physique et d'Hist. Nat. Genève, vol. xxx, 2, p. 112, pl. viii, figs. 3–6.

1916. Gregory, Trans. Roy. Soc. Edinburgh, vol. li, 3, p. 585.

This species is represented by several specimens in the Loanda collection. They are divisible into two varieties, as Gregory has pointed out—a broad high form, and a broad, depressed form. A number of measurements were given by Gregory, and it is not necessary to add further figures.

Localities.—R 40 (S.A.M., 6803), 4 km. E. of Camballa village, Cuvo River—about 500 ft. over Upper Gypsum horizon.

R 29 (S.A.M., 6802), S. end of sea-cliffs, S. of Benguella Velha, 1900 ft. over Upper Gypsum horizon.

R 22 (S.A.M., 6875), 1900 ft. over Upper Gypsum horizon.

L 68 (S.A.M., 6780), doubtful.

Epiaster angolensis sp. nov.

Founded on three good specimens, two of which are more elongate than the third. The measurements of the three are as follows :—

Length.	Breadth.	Height.	
43 mm.	39·0 mm.	30 mm.	
42 ,,	37·5 ,,	26 ,,	(flattened).
36 ,,	34·5 ,,	25 ,,	

The form differs considerably in profile from *E. catumbellensis*, the greatest height being just behind the apical disc, and the posterior interambulacrum sloping gently to meet the vertical posterior face. In size and general appearance the form is comparable with *E. incisus* from the Albian of Algeria ; but in the Angola species the apical disc is more anterior. The position of the disc is variable in *incisus* as figured by Cotteau, Peron, and Gauthier, but it is there either central or posterior and never anterior.

In the unpaired ambulacrum the pores are small, slightly elongate, and oblique, and each pore is separated from the other one of a pair by a granule. This granule is not mentioned in descriptions of *incisus*, although it is present in the Cenomanian *henrici* of Algeria (from which *angolensis* differs in proportions) and in *distinctus* d'Orbigny. The interporiferous area is lightly granulate.

In the paired ambulacra the pores are elongate slits, more elongate and closer together than in *catumbellensis*.

Types.—S.A.M., Cat. Nos. 6804 *a–c*.

Locality.—Base of N'Golome marl, with large ammonites. Collected by K. D. W. White.

Genus Isaster Des.

Isaster benguellensis P. de Loriol.

1888. P. de Loriol, Arch. des Sc. Bibl. Univ., 3e per., t. 19, No. 1, Geologie d'Angola, p. 5.

1888. P. de Loriol, Mém. Soc. de Physique et d'Hist. Nat. Genève, vol. xxx, 2, p. 108, pl. viii, figs. 1–2.

One specimen in the collection seems to agree with the type of this form. It is somewhat crushed, as is the type; its length is about 60 mm., its width about 57 mm., and its height between 35 and 40 mm.

The middle of the apical disc is occupied by the spongy madreporite; the posterior genital pore is imperforate.

Locality.—S. end of sea-cliffs, S. of Benguella Velha. Collected by L. Reinecke.

Genus Hemiaster Ag.

Hemiaster reineckei sp. nov.

Three specimens of a *Hemiaster* seem to be readily distinguishable from any described species, and are therefore described as a new form—the best preserved (S.A.M., Cat. No. 6807) being taken as the type.

The type specimen has a length of 59 mm., a breadth of 57 mm., and a height of 31 mm.; but the other two are broader—the breadth being equal to, or slightly greater than, the length. The shape is generally like that of *Epiaster vatonnei*, but there is undoubtedly a peripetalous fasciole present.

The apical disc is almost central, and of the usual type, with four perforated genitals.

All the ambulacra are in shallow grooves.

The pores of the unpaired ambulacrum are elongate, but not to such an extent as in the paired ambulacra; they are slightly oblique, being most oblique near the lower ends; and they are not conjugate.

Anterior paired ambulacra broad, and extending almost to the circumference of the test where they form a slight concavity in the outline of the shell; pores very elongate, straight, each pair in the same straight line, the outer pores slightly longer than the inner, conjugate; poriferous zones wider than interporiferous area, and carrying small and irregular granules; interporiferous areas smooth.

Posterior paired ambulacra long, but shorter than the anterior pair.

Periproct slightly oval, small, in middle of the posterior face. The anal area is not defined.

Peristome not seen.

Tubercles small and numerous, regularly spaced. Granules abundant, particularly in the fasciole.

In its long paired ambulacra this form approaches *H. cubicus*

and *H. saulcyanus* ; but in its general form it is readily distinguishable from either.

Type.—S.A.M., Cat. No. 6807, R 34*a*.

Locality.—E. of N. end narrow lagoon S. by E. of Camballa Village, N. of Cuvo River. Collected by L. Reinecke. 800–1500 ft. above Upper Gypsum horizon.

R 26 and R 41. S. end of sea-cliffs, S. of Benguella Velha. 1900 ft. above Upper Gypsum horizon.

Genus Macropneustes Ag.

Macropneustes sp. cf. *Baylei* Coquand.

1862. *M. Baylei,* Coquand, Mém. Soc. d'Emul. Provence, vol. ii, p. 274, pl. xxxi, figs. 12, 13.

1885. Cotteau, Peron, and Gauthier, Echinides foss. de l'Algerie, fasc. 9, p. 53.

There are two specimens in the collection which I refer with some hesitation to this Upper Eocene species, of which I have not had the opportunity to see a figure. Neither of the specimens is well-preserved, but some of the features are discernible. One specimen is nearly twice as large as the other. The measurements are as follows :—

	Length.	Breadth.	Height.
6761*a* . . .	43 mm.	40 mm.	21 mm.
6761*b* . . .	70 ,,	63 ,,	31 ,,

The form is thus somewhat flat, longer than wide, and differs from *Hemiaster* in that the posterior paired ambulacra are longer than the anterior pair.

Apical disc in front of the centre ; genital pores close together.

Periproct large, filling nearly the whole of the short vertical face.

Unpaired ambulacrum in a shallow groove ; pores small, round, and oblique.

Paired ambulacra in shallow grooves ; pores elongate, horizontal, inner pore of each pair smaller than outer ; pores of each pair conjugate. Interporiferous area narrow, carrying two rows of small tubercles.

Tubercles of interambulacra perforate and crenulate with smooth areole. Primary tubercles somewhat sparsely distributed. Test granulate.

Peripetalous fasciole narrow and smooth, passing above periproct.

Locality.—7 km. S. 65° E. of Capolo Guedes. Collected by O. F. Ernster and J. J. Macgowan.

Genus Cidaris Klein.

Cidaris malheiroi P. de Loriol.

1888. P. de Loriol, Mém. Soc. Physique et d'Hist. Nat. Genève, vol. xxx, 2, p. 97, pl. vi, figs. 1, 5–7.

A single, somewhat weathered specimen is somewhat larger than the type, but agrees in every other character with the description given by de Loriol.

Locality.—(S.A.M., Cat. No. 6810). On ridge E. of lagoon, Camballa Village, Cuvo River. Between 800 and 1600 ft. over Upper Gypsum horizon. Collected by L. Reinecke.

Genus Orthopsis Cott.

Orthopsis cf. *Ruppelli,* Desor.

(For bibliography of this species, see 1914, Fourtau, Cat. Invert. foss. de l'Egypte, Terr. Cret., pt. 1, p. 22, pl. ii, figs. 5–6.)

Dimensions :—

	Length.	Breadth.	Height.
6809*a* . . .	34 mm.	34 mm.	16 mm.
6809*b* . . .	33 ,,	33 ,,	15 ,,
6809*c* . . .	29 ,,	29 ,,	13 ,,

Form subcircular or subpentagonal, depressed.

Apical disc of ten plates, the two posterior oculars forming part of the periproctal border as in specimens of *O. ruppelli* described by Fourtau from Egypt. Madreporic plate larger than the other genitals.

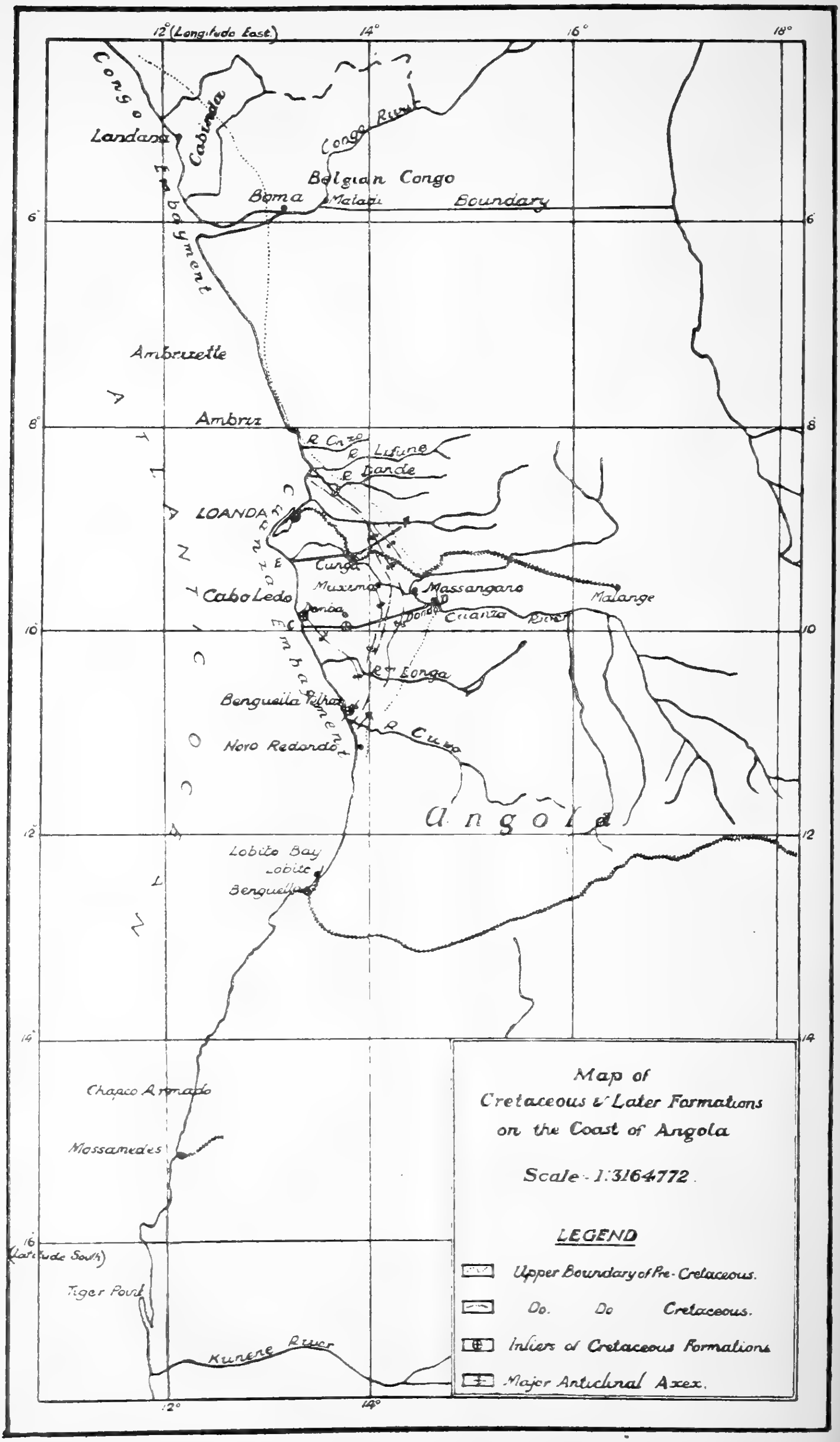
Ambulacra narrow, slightly more than one-third the width of the interambulacra. Poriferous zones straight, simple. Each ambulacrum carries two rows of primary perforate, non-crenulate tubercles which diminish in size towards the apex ; between the tubercles are granules.

Interambulacral area carries two rows of primary tubercles. Secondary tubercles occur, especially on the lower surface ; but the test is too weathered to define their exact positions. The secondary tubercles disappear towards the apex.

Peristome at bottom of a depression on lower surface. Periproct somewhat irregular.

The ornamentation is less profuse than in *O. miliaris* from Algeria, and bears great resemblance—as far as comparison is possible—with that of *O. ruppelli*. The test is, however, more elevated in the latter species than in the Angola form. In its depressed form it is very close to *O. libanotica* de Loriol from the Cenomanian of Syria, as also in the comparatively rapid disappearance of the secondary tubercles.

Locality.—On ridge E. of lagoon, Camballa Village, Cuvo River. Collected by L. Reinecke. Between 800 and 1600 ft. above Upper Gypsum horizon.



12° (Longitude East.)
14°
16°
18°
Congo
Landana
Cabinda
Congo River
Belgian Congo
Boma
Matadi
Boundary
Embayment
Ambrizette
Ambriz
R. Lifune
R. Dande
LOANDA
Cunga
Muxima
Massangano
Malange
Cabo Ledo
Dondo
Cuanza River
R. Longa
Benguella Velha
R. Cuvo
Novo Redondo
Angola
Lobito Bay
Lobito
Benguella
Chapeo Armado
Mossamedes
(Latitude South)
Tiger Point
Kunene River
Map of
Cretaceous & Later Formations
on the Coast of Angola
Scale - 1:3164772.
LEGEND
Upper Boundary of Pre-Cretaceous.
Do. Do Cretaceous.
Inliers of Cretaceous Formations
Major Anticlinal Axes.

INDEX.

EXPLANATION OF PLATES.

Plate XII.

1. *Phylloceras angolense* Htn. Side view of type. Cat. No. 6527.
2. Do. Outline of ventral view of type specimen.
3. *Phylloceras surya* (Forbes). Side view of specimen No. 6840.
4. Do. Outline of ventral view of specimen No. 6840.
5. Do. Side view of specimen No. 6739.
6. *Inflaticeras spathi* Htn. Side view of type specimen. Cat. No. 6530.
7. Do. Outline of ventral view of type, showing section of last whorl.
8. Do. Outline of ventral view of type, showing ornamentation.

Plate XIII.

1. *Menuites macgowani* Htn. Side view of type specimen. Cat. No. 6742.
2. Do. Outline of ventral view of type.
3. Do. Ventral view of type specimen.
4. *Placenticeras reineckei* Htn. Side view of type specimen. Cat. No. 6523.
5. Do. Details of suture-line on last whorl of type specimen.

Plate XIV.

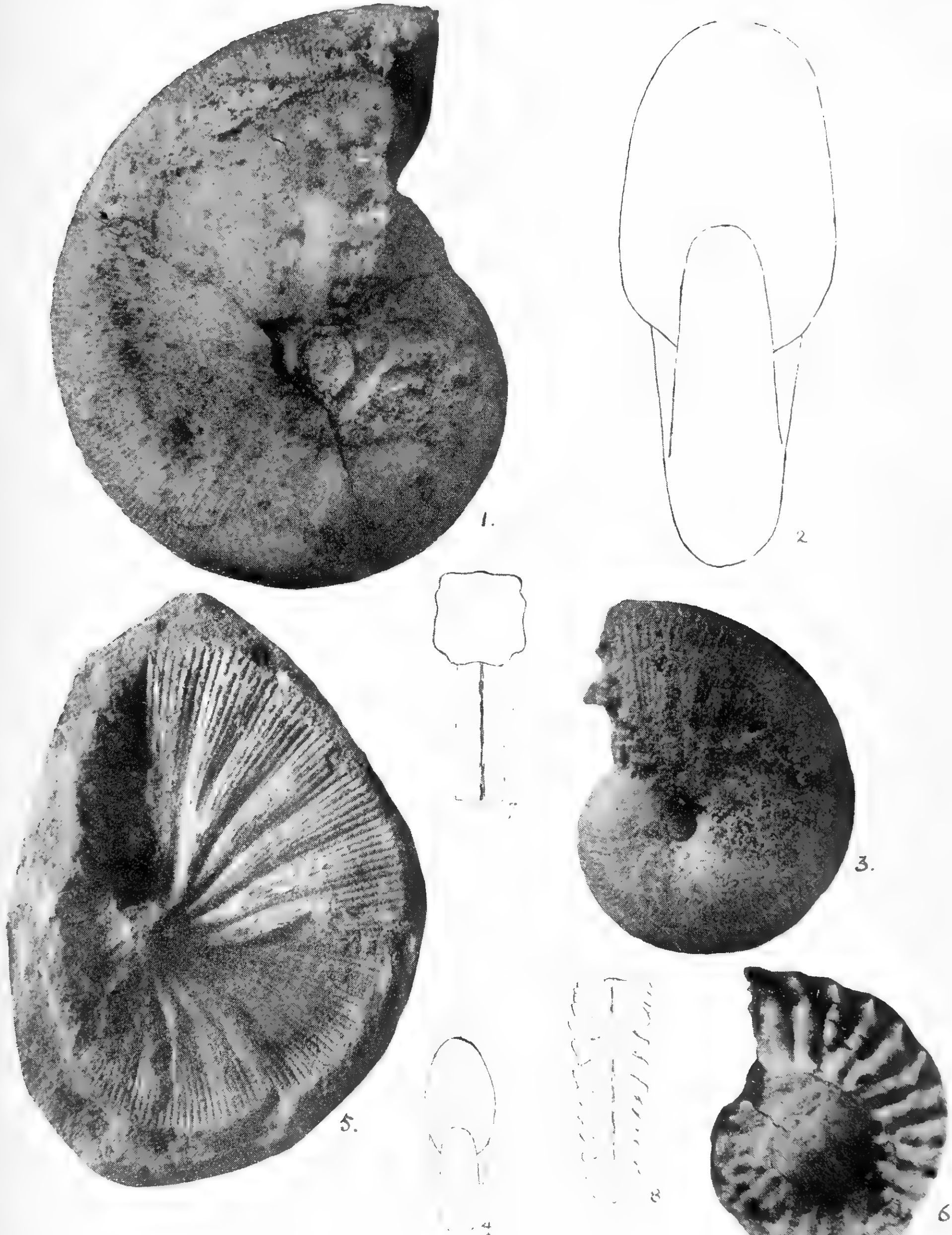
1. *Libycoceras angolense* Htn. Side view of type specimen. Cat. No. 6891.
2. Do. Outline of cross-section of type.
3. Do. Details of suture-line at diameter of 14 mm. Cat. No. 6891.
4. Do. Details of suture-line at diameter of 46·5 mm. Cat. No. 6891.
5. Do. Details of suture-line at diameter of 70 mm. Cat. No. 6891.
6. *Baculites subanceps* Htn. View of largest specimen No. 6829.

6*a*. Do. Details of last suture on specimen No. 6829.

7. Do. Cross-section at a diameter of 14 mm. Specimen No. 6829.
8. Do. Cross-section through body-whorl. Specimen No. 6829.
9. *Baculites* sp. Shape of cross-section. Specimen No. 6744.

Plate XV.

1. *Nostoceras angolense* Htn. View of type specimen.
2. *Didymoceras hornbyense* (Whiteaves). Ventral view of Specimen No. 6852.
3. *Didymoceras* sp. Ventral view of specimen No. 6743.
4. *Hemiaster reineckei* Htn. Type specimen No. 6807.
5. *Epiaster angolensis* Htn. Specimen No. 6804.
6. *Orthopsis* cf. *ruppelli* Desor. Specimen No. 6809*b*.



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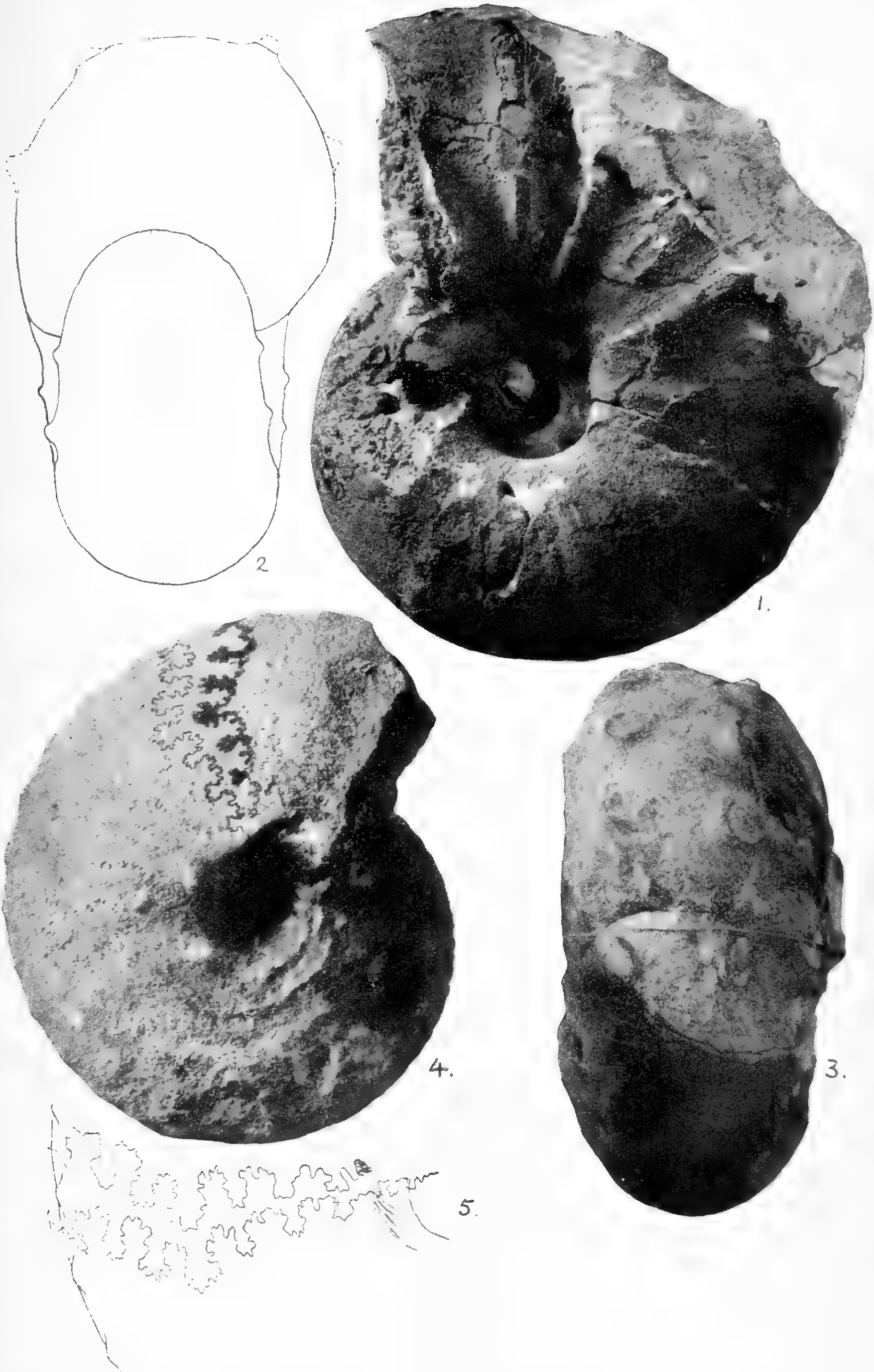

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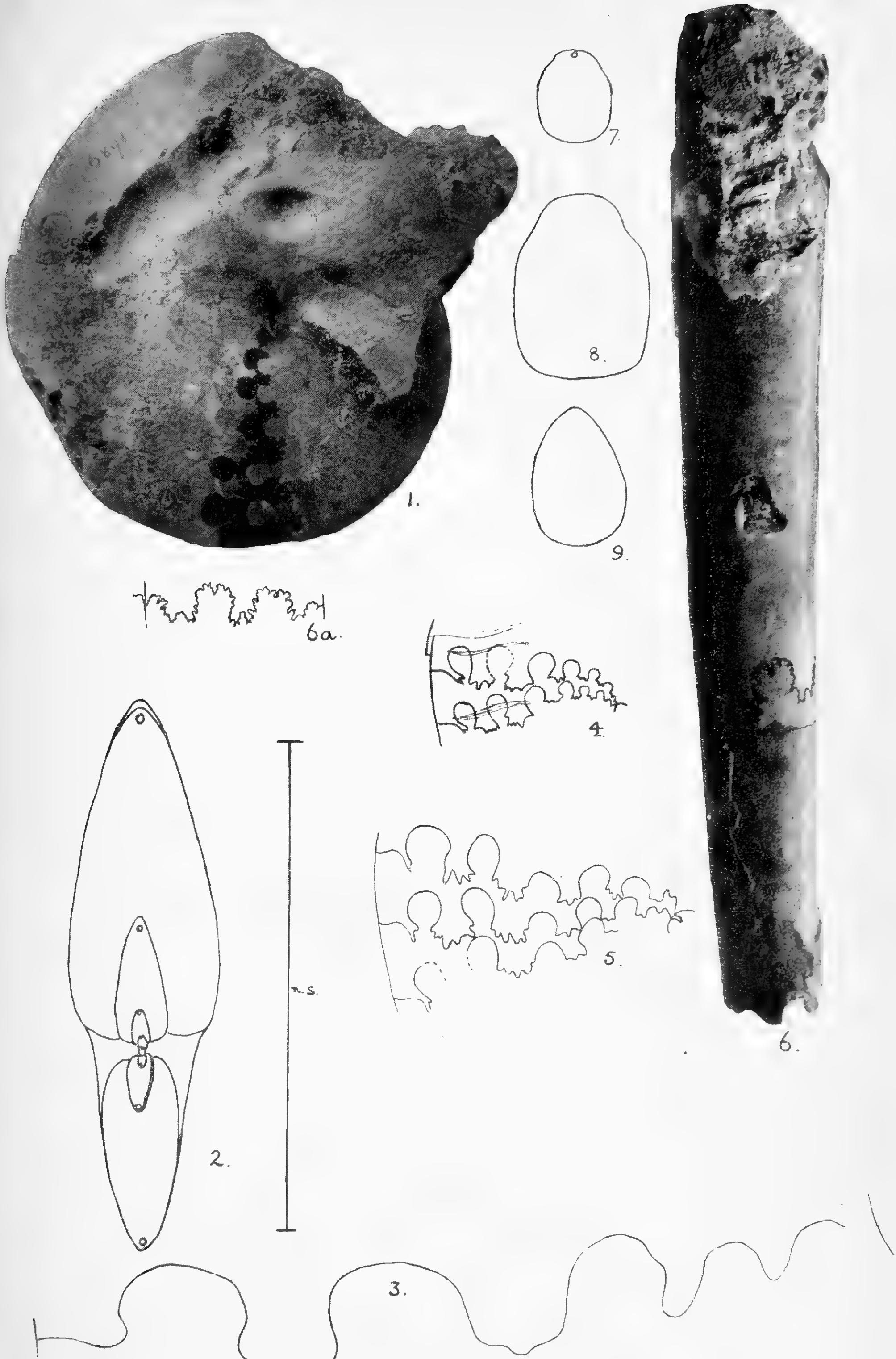

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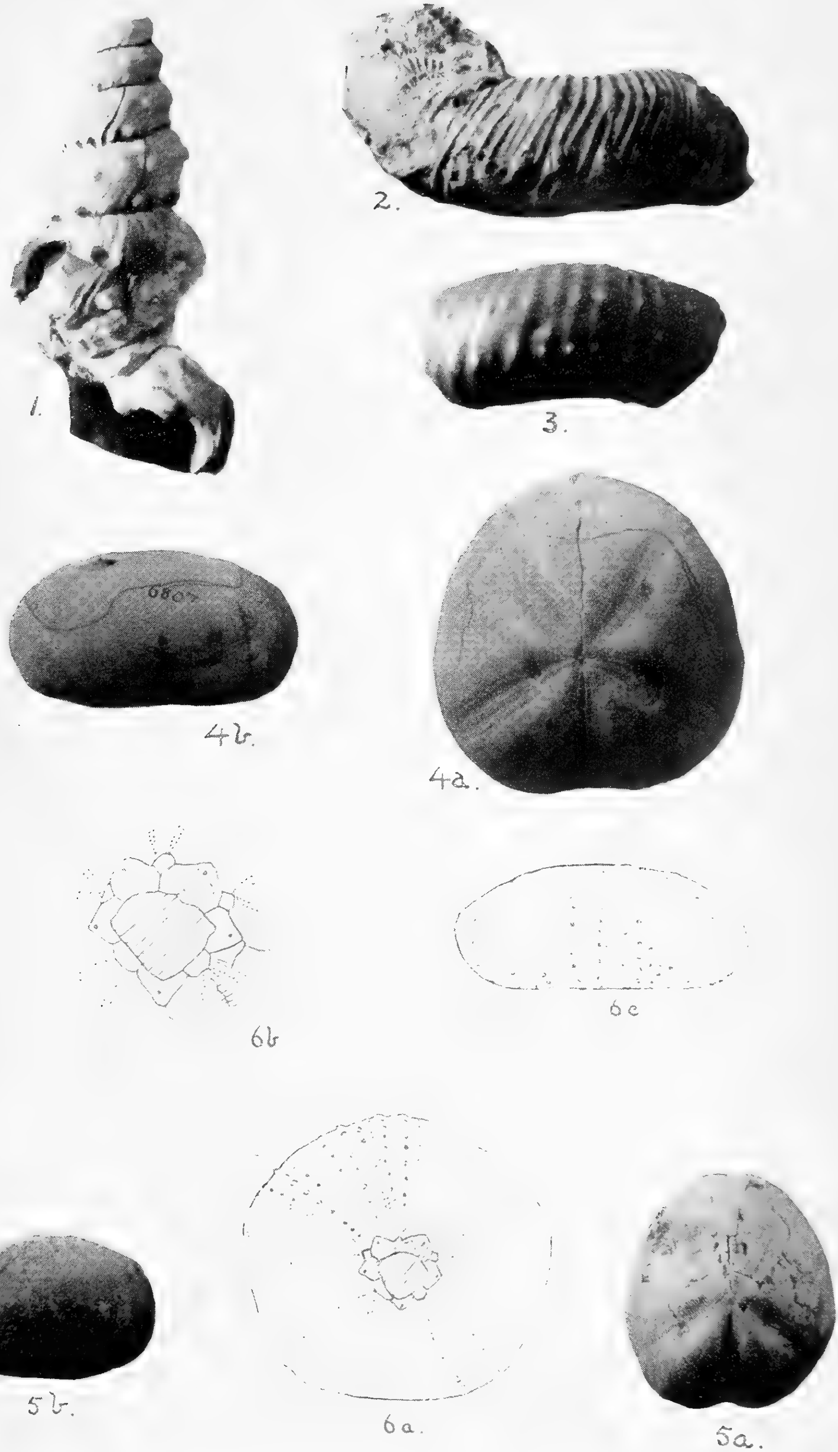

CRETACEOUS CEPHALOPODA AND ECHINOIDEA FROM ANGOLA.

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ANNALS

OF THE

SOUTH AFRICAN MUSEUM

VOLUME XXII.

DESCRIPTIONS OF THE PALAEONTOLOGICAL MATERIAL COLLECTED BY THE SOUTH AFRICAN MUSEUM AND THE GEOLOGICAL SURVEY OF SOUTH AFRICA

PART II, *containing*:—

5. *The Fossil Flora of the Upper Karroo Beds.* By ALEX. L. DU TOIT, D.Sc., F.G.S. (With Plates XVI–XXXII and 24 Text-figures.)

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5. *The Fossil Flora of the Upper Karroo Beds.*—By ALEX. L. DU TOIT, D.Sc., F.G.S.

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PREFACE.

THE following account does not profess to be an exhaustive review of the flora of the upper portion of the Karroo System of South Africa, for the collections of the Union Geological Survey and of the various South African museums still contain a good deal of material not yet worked up, and, though including much fragmentary or poorly preserved remains, certainly embracing species and probably genera not yet recorded from this country.

In preparing the illustrations in this memoir it has been the considered policy to avoid the use of photographs. Many an important palaeobotanical paper can be cited in which the figures consist largely of blurred prints in which occasionally even the outlines of the plants can hardly be traced, much less the essential venation characters. Certain of the specimens figured here are of impressions on black shale, and close examination has not uncommonly been necessary to make out the finer detail. Every care has, however, been taken to depict the fossils with the requisite degree of accuracy, and it is hoped that the strictures so generally made in regard to drawings will not apply in this case.

Unless otherwise stated, the illustrations have been drawn to natural size.

ALEX. L. DU TOIT.

PRETORIA,
April 1927.

CONTENTS.

I.—*THE UPPER KARROO BEDS.*

STRATIGRAPHICAL.

In contrast to the lower divisions of the Karroo System, which contain scanty remains with relatively few forms, mainly belonging to the Glossopteris Flora, the upper portion yields fossil plants in fair quantity, including many representatives of more widely distributed genera and species. The rather poor Permo-Triassic "*Glossopteris* assemblage" of Gondwanaland has indeed now been replaced almost entirely by the more abundant and cosmopolitan Trias-Rhaetic "*Thinnfeldia* Flora."

In the upper part of the system the plants are found principally in certain zones or in thin layers of blue, grey, or carbonaceous shale that characterise the Molteno Beds, the lowest member of the Stormberg Series, a group that is coal-bearing. There are two prolific localities, (1) Konings Kroon in the Elliot district, where a band only about a foot thick of grey cherty rock is crowded with beautifully preserved plant remains, and (2) the "Waterfall" at the head of the Umkomaas River in Natal, where a thin zone of carbonaceous shales is rich in genera and species.

In tabular form the succession in the Union is as follows :—

		Maximum Thickness in Feet.
Stormberg Series	5. Basaltic lavas . .	5000
	4. Cave Sandstone .	800
	3. Red Beds . .	1600
	2. Molteno Beds . .	2000
Beaufort Series.	1. Upper Beaufort Beds.	1500

There is a general thinning of the sedimentary groups to the north and north-east, such being particularly marked in the case of the Molteno Beds, which die out just before Harrismith, but the higher divisions are represented farther to the north in the Transvaal and Southern Rhodesia.*

1. The Upper Beaufort Beds, the lowest group with which we are concerned, comprises thick beds of yellowish or buff felspathic sandstone and flagstone, alternating with thicker bodies of reddish, maroon, blue, buff, and green—often mottled—shales, mudstones, and flagstones. These softer strata, which are of the type known as "Basin Deposits," have yielded a fairly abundant fauna of reptiles, amphibians, and fishes, such as *Cynognathus*, *Gomphognathus*, *Erythrosuchus*, *Cyclotosaurus*, *Capitosaurus*, *Ceratodus*, *Cleithrolepis*, and *Helichthys*, which indicate an age ranging from about the *Lower* to the *Middle Triassic.*

Vegetable remains are not too abundant, but the uppermost portion has furnished in addition to silicified wood a fair number of plants, preserved mainly as impressions in the enclosing sandstones, more rarely in the drab or greenish mudstones, the most important source being the stone quarries at Aliwal North, whence was gathered during a period of many years the "Brown Collection," now in the South African Museum.

2. The Molteno Beds are readily distinguishable from the deeply coloured sediments above as well as below by the typically grey and blue tint of the shales, the coarse grain, "sparkling" appearance, and often pebbly character of the dominating sandstones, and the occasional seams of coal. The group actually constitutes a "wedge" of strata between the two groups of coloured beds, one that attains a maximum thickness in the south between Elliot and Glen Grey and thins out uniformly in the distance of 300 miles to Harrismith. The resistant nature of the sandstones gives rise to terraced country and

* For details see Du Toit, 1926, pp. 229–235; and Haughton, 1924.

the softer plant-bearing bands may over considerable distances be concealed by soil or talus.

Vertebrate remains are absent. The formation represents in great part a deltaic deposit.

3. The Red Beds are, as their name denotes, composed of white, grey, or yellowish grits and sandstones and brilliantly coloured mudstones and soft sandstones, much like those of the Upper Beaufort Beds, which indicates a return to "interior basin" conditions, apparently under a semi-arid climate. The strata contain silicified wood and vertebrate remains, chiefly of "dinosaurs" such as *Thecodontosaurus*, *Euskelesaurus*, and *Massospondylus*.

4. The Cave Sandstone is a thick massive bed of fine-grained sandstone, white, cream, or pink in colour, which has yielded bones of dinosaurs—*Thecodontosaurus*, *Gryponyx*; pseudosuchians—*Sphenosuchus*, *Erythrochampsa*; and the fish *Semionotus*.

The vertebrates of this and the preceding group are of *Upper Triassic and Rhaetic* affinities, none of the genera being found in the Liassic of Europe.

5. The Basaltic Lavas terminate the Karroo succession. Only a few fragments of vegetable origin have been obtained as yet from one of the intercalated layers of sediment in the basal part of the group, so that a Liassic age for the volcanics has to be arrived at in an indirect fashion.

THE PLANT-BEARING ZONES.

It would be of advantage to subdivide the mass of strata into palaeobotanical stages, of which seven can be made, though only three are as yet of importance. In time to come the highest and lowest subdivisions, which are but scantily fossiliferous, should furnish valuable material.

A. *The Lower and Middle Portion of the Upper Beaufort Beds.*—This has yielded but few remains, principally silicified wood, probably *Dadoxylon*, striated stems belonging to *Schizoneura* or *Neocalamites*, and fronds of *Danaeopsis hughesi*.

B. *The Uppermost Portion of the Upper Beaufort Beds.*—This embraces under 300 feet of strata, which, while lithologically belonging to the Beaufort Beds, contains representatives of the *Thinnfeldia* Flora of the higher stages. The Brown Collection has largely been gathered from this zone.

Thinnfeldia, *Taeniopteris*, *Callipteridium*, and *Ginkgoites*

are present in it as in stage C, but there are several genera not yet known on higher horizons, such as *Danaeopsis, Odontopteris, Nilssonia*, and *Stigmatodendron.*

C. *The Basal Portion of the Molteno Beds.*—This embraces the few hundred feet of mainly shaly strata up to the base of the Indwe Sandstone and includes the Indwe Coal horizon. It has produced many genera and species, the majority of which appear again in stage D ; only a few are restricted to stage C, for example *Cladophlebis rösserti, Marattiopsis münsteri*, and *Thinnfeldia narrabeenensis.*

D. *The Middle Portion of the Molteno Beds.*—This consists of not more than about 100 feet of shaly beds overlying the Indwe Sandstone and including the horizon of the Molteno and Cyfergat Coals and the "oil shales" of Natal. This is extremely rich in forms, including many unknown in the lower stages, such as species of *Cladophlebis, Taeniopteris, Chiropteris, Pachypteris, Glossopteris, Ginkgoites, Pterophyllum*, and *Pseudoctenis.* On this horizon the flora reaches its zenith.

E. *The Upper Portion of the Molteno Beds.*—This stage is surprisingly poor in plant remains, though silicified wood is abundant ; *Thinnfeldia, Baiera, Phoenicopsis*, and *Schizoneura* are occasionally to be found.

F. *The Red Beds.*—Silicified wood is not uncommon, but only at one spot, in the Wodehouse district, has a band of dark shales been discovered containing in addition to valves of *Cyzicus* (*Estheria*) a frond referred to *Pachypteris*, while elsewhere one of the sandstones has yielded a stem of *Schizoneura.*

G. *The Cave Sandstone.*—This is known to furnish only silicified wood, as yet undetermined.

The principal plant-bearing group—the Molteno Beds—makes a wide belt of country that surrounds the Basutoland region and embraces the Stormbergen, the foothills of the Drakensbergen from Indwe to near Van Reenens Pass in Natal, the eastern edge of the Orange Free State, and parts of Herschel and Aliwal North. From within this great region several hundreds of miles in length, plants have been discovered at many points, though systematic collecting has only been done at comparatively few places, mainly by the Geological Survey on the southern and south-eastern sides. The most important spots are Molteno, Cyfergat, Jamestown, Dordrecht,

Indwe, Cala, Konings Kroon (Elliot), Maclear, Fletcherville, Kenigha Drift (Tina R.), the headwaters of the Umkomaas River (Natal), Witzies Hoek (Harrismith). Plants have also been gathered at Senekal and Zastron in the Orange Free State. The most abundantly represented genera are *Thinnfeldia, Phoenicopsis, Baiera,* and *Stenopteris* ; *Taeniopteris* and *Ginkgoites* are rare.

Neither the Upper Beaufort nor the Molteno Beds are represented in the Transvaal, but plants mainly of Molteno genera or species have during late years been discovered in the Forest Sandstone of Southern Rhodesia, which is the equivalent of the Cave Sandstone, Red Beds, and just possibly of part of the Molteno Beds of the Union. Because of their importance these discoveries are referred to in this work (p. 409) and one new form figured.

It is greatly to be desired that more systematic collecting be done, for there is no doubt that the present list would thereby be considerably extended, a work that ought to be done by the museums. Larger specimens are required, for many of the types are incomplete and sometimes only known from fragments ; no complete pinnule of any species of *Taeniopteris* has yet been obtained in the Union.

Attention should particularly be paid to the Beaufort Beds in order to decide the important question whether the flora thereof shows, as would appear to be the case from the short list available, affinities with that of the Triassic of Europe. The upper part of the Stormberg Series ought to be searched for plant remains, while a study of the silicified woods from different horizons is eminently desirable.

PREVIOUS INVESTIGATIONS.

The first account of the Molteno Flora was contributed by O. Feistmantel in 1889, though E. J. Dunn had long before identified several forms with species known in the Mesozoic of Queensland and Tasmania. Not until 1903 was anything further done, when A. C. Seward gave a description largely of material collected by the Cape Geological Survey in the district of Matatiele. Certain of the plants obtained by the writer in Aliwal North, Wodehouse, Xalanga, and Elliot were in 1908 described by Seward, who also announced the new genus *Stormbergia* in 1912.

The first elucidation of the curious stem *Rhexoxylon* was given by Miss N. Bancroft in 1913, while further examples were described by J. Walton in 1923, who subsequently examined a selected series of the fossil woods from several Karroo horizons. In 1921 appeared a paper by Seward and Holttum on the plants of the Somabula Beds of

Rhodesia, and in 1925 a second paper on some new material therefrom by J. Walton, while in 1927 the writer described briefly *Cyparissidium* from Mafungabusi, Southern Rhodesia.

Since 1908 a good deal of collecting has been done by the writer in various spots, while the acquisition of the Brown Collection of plants by the South African Museum rendered it imperative that such new material should be examined, though this task has at sundry times been interrupted and so spread over a number of years. In 1924 a preliminary list was furnished to Dr. S. H. Haughton * and published by him in his paper on the Stormberg Series, but some of the identifications have had to be revised, chiefly as the result of papers by Walkom, Halle, and others, on the equivalent Mesozoic floras elsewhere. The short list printed in 1926 in "The Geology of South Africa" † includes hardly any of the new genera and species, as it was thought preferable in a text-book to omit references to undescribed material.

The specimens described in this work are in most cases preserved in the South African Museum, Cape Town, while those from S. Rhodesia are in the possession of the Geological Survey, Salisbury. The type of *Ctenopteris* from Somabula was, through the kindness of Mr. H. B. Maufe, the Director of the Survey, re-examined and found to be a *Thinnfeldia*, while to Mr. J. Hewitt, Curator of the Albany Museum, Grahamstown, the writer is indebted for the opportunity of studying the type of *Stormbergia*.

OPINIONS AS TO THE AGE OF THE MOLTENO BEDS.

In the absence of marine fossils and the scarcity of vertebrate remains, the determination of the age of the Stormberg Series has rested largely upon the affinities of the Molteno Flora.

The conclusion arrived at by Feistmantel ‡ long ago of a *Rhaetic Age* for the latter was also reached by Seward,§ a view that has hitherto remained almost unquestioned, though in the light of further information such is not quite assured. It is certainly indisputable that the Molteno assemblage shows strong affinities with floras from beds both of undoubted and of presumed Rhaetic age in various parts of the world, such as Sweden, Germany, Persia, India, Indo-China, Japan, Australia, Tasmania, New Zealand, Argentina, Chile, and

* Haughton, 1924, pp. 323–324.
† Du Toit, 1926, p. 275.
‡ Feistmantel, 1889, p. 73.
§ Seward, 1903, p. 73; 1908, p. 104.

Honduras. On the other hand the study of the vertebrates from the overlying Red Beds and Cave Sandstone, principally by Dr. Haughton,* has been rather tending to prove an Upper Triassic age. Furthermore, the vertebrates from the Upper Beaufort Beds have distinctly Triassic, mainly Lower to Middle, affinities, wherefore the Molteno Beds from these lines of evidence should be of Upper Triassic age.

It therefore seemed that fuller discussion was urgently required as to the palaeobotanical grounds upon which such a Rhaetic age had primarily been based, the more so since such a number of new forms had come to light, including several of distinctly palaeozoic aspect.

CRITERIA FOR AGE DETERMINATION.

In making such an analysis it should be emphasised that only such floras as come from *plant-bearing zones in immediate association with beds possessing a determinable marine fauna* could be of any real use in this discussion, since only through such a connection with invertebrate zone-fossils could standard or reference florules be established, which could then be used in comparison against the Molteno assemblage.

This postulate will eliminate at once the bulk of the regions with which comparisons have generally been made, *i.e.* India, Australia, Tasmania, New Zealand—unfortunately most of Gondwanaland. The existence of common genera and of allied or even identical species in any one of these particular countries, though of course vital in proving the contemporaneity of, or but relatively slight differences in, age of the strata of such widely separated regions, gives no actual help in this special investigation, and may even lead to erroneous conclusions. To give an illustration, the Rajmahal Beds of India are commonly regarded as Jurassic. The few Rajmahal species present in the Molteno Beds might therefore be considered as Jurassic elements in the latter, though, on the contrary, were the Molteno Beds to be determined as Triassic, these forms could with equal right be viewed as introducing Triassic affinities into the Rajmahal Flora.

Adopting the above policy, there remain for analysis and comparison only the following countries, which will be taken in the following order:—Sweden, Germany, Persia, Indo-China, Japan, Chile, and Argentina.

* Haughton, *loc. cit.*, p. 490.

II.—*TRIAS-RHAETIC FLORAS.*

1. SWEDEN.

A most important area of Mesozoic Beds lies around Bjuf in the province of Schonen,* where fresh-water plant- and coal-bearing strata pass upwards into beds with marine intercalations containing Rhaetic and Liassic mollusca, the association being such as to prove the Rhaetic age of certain of the plant-bearing layers.

At the base, resting on much older rocks, is a group up to 200 metres in thickness of reddish sandstones and variegated clays, which, though unfossiliferous, have been relegated to the Keuper. Above this follows the group allotted to the Rhaetic, generally less than 100 metres in thickness, with the following zones on proceeding from the base to the summit : (a) *Dictyophyllum exile*, (b) *Camptopteris spiralis*, (c) *Lepidopteris ottonis*, (d) *Equisetites gracilis*, (e) *Thaumatopteris schencki*, (f) *Pullastra elongata* (lamellibranch), (g) *Dictyophyllum acutilobum*, and (h) *Nilssonia polymorpha*. The still higher strata are generally agreed to represent the Liassic, with the Hör Sandstone, up to 20 metres thick at the most, at the base, and containing in addition to plants various layers characterised by marine mollusca, such as *Mytilus*, *Cardinia*, *Cyclas*, *Pteria* (*Avicula*), and *Cardium*, by which their precise age is established.

The Hör Sandstone has yielded among others the following :—†

Equisetites scanicus (Stern.).
Dictyophyllum nilssoni (Brong.).
Nilssonia brevis, Brong.
Anomozamites major, Brong.
Pterophyllum intermedium, Antevs.
Stenorrachis dubius, Antevs.

None of these is represented in the Molteno Flora.

To the undoubted Rhaetic can be ascribed the following, only a few of which range up into the Lower Lias :—

Equisetites gracilis (Nath.).
,, *münsteri* (Sternb.).
,, *levis*, Halle.

* For details see Törnebohm and Hennig, 1904, pp. 88–109 ; Erdmann, 1911–15, pp. 9–42 ; Högbom, 1913, pp. 80–85.

† Antevs, 1919.

Neocalamites hörensis (Schimp.).
Cladophlebis nebbensis (Brong.).
,, (*Todites*) *rösserti* (Presl).
Marattiopsis münsteri (Göpp.).
Lepidopteris ottonis, Göpp.
Sagenopteris undulata, Nath.
,, *nilssoniana*, Brong.
Thinnfeldia rhomboidalis, Etting.
,, *rotundata*, Nath.
,, *major* (Racib.).
,, *polymorpha* (Braun).
,, *nordenskioldi*, Nath.
Camptopteris spiralis, Nath.
Clathropteris meniscoides, Brong.=*C. reticulata.*
Thaumatopteris schencki, Nath.
Taeniopteris immersa, Nath.
,, *obtusa*, Nath.
,, *tenuinervis*, Brauns.
,, *gigantea*, Sch.
Dictyophyllum exile, Brauns.
Baiera paucipartita, Nath.
Pterophyllum aequale (Brong.).
Anomozamites gracilis, Nath.
Nilssonia polymorpha, Sch.
Ptilozamites (several species).
Podozamites distans, Presl.
,, *schencki*, Heer.
Stenorrachis scanicus, Nath.
Schizolepis obtusa, Nath.
Cyparissidium nilssonianum, Nath.

2. FRANCE.*

Close to Autun the lower part of the *Pteria* (*Avicula*) *contorta* zone has yielded the following plants :—

Equisetites arenaceus (Brong.).
Taeniopteris vittata, Brong.
,, *tenuinervis*, Brauns.
Clathropteris meniscoides, Brong.=*C. platyphylla.*

* De Lapparent, 1905, p. 1096.

3. GERMANY.*

There are *three* very important plant-bearing zones. The UPPERMOST HORIZON is well seen in the neighbourhood of Bamberg and Bayreuth, and containing as it does *Pteria contorta*, is undoubtedly of Rhaetic age. It has a flora that includes among others the following forms :—

Equisetites münsteri (Sternb.).
Cladophlebis (*Acrostichites*) *göppertiana* (Sch.).
,, (*Pecopteris*) *concinna* (Presl).
,, (*Todites*) *rösserti* (Göpp.).
Marattiopsis münsteri (Göpp.).
Lepidopteris ottonis Göpp.
Sagenopteris rhoifolia, Presl.
Thinnfeldia rhomboidalis, Ett.
,, *decurrens* (Braun).
,, *obtusa*, Schen.
,, *polymorpha* (Braun).
Clathropteris meniscoides, Brong.=*C. platyphylla*.
Thaumatopteris münsteri, Göpp.
,, *brauniana*, Popp.
Taeniopteris tenuinervis, Brauns.
,, *stenoneura*, Schen.
Baiera taeniata, Brauns.
Pterophyllum braunianum, Göpp.
,, *münsteri*, Göpp.
,, *propinquum*, Göpp.
Anomozamites inconstans (Braun).
Nilssonia polymorpha, Schen.
,, *acuminata*, Göpp.
Otozamites brevifolius, Braun.
Podozamites distans, Presl.
,, *schencki*, Heer.

At this stage an interpolation must be made. Various persons have pointed out the very close resemblances of certain of these forms with others from the Liassic, Seward having for instance instituted comparisons with species belonging to the Lower Oolite of Yorkshire. This attitude, however, transgresses a most important principle which cannot be ignored. When undoubted Rhaetic assemblages, such as those of Scania, Franconia, Japan, and possibly Persia, are

* Lepsius, p. 457 ; Schenck, 1868 ; Frentzen, 1921, 1922, 1922*a*.

being compared with florules of the Jurassic, the proper attitude logically, as well as from the evolutionary viewpoint, should be to regard these particular forms in the Jurassic as actually possessing, or else as retaining, Rhaetic characters and not the reverse. This aspect will again have to be stressed when dealing with the relationships of the Molteno Flora.

The Second and Middle Horizon is the well-known "Schilf Sandstein" belonging to the Upper Keuper, in which among others the following have been found :—

Equisetites arenaceus (Brong.).
,, *platyodon* (Brong.).
Neocalamites meriani (Brong.).
Cladophlebis (*Neuropteris*) *remota* (Presl).
Danaeopsis marantacea, Presl.
Asterotheca meriani (Brong.).
Clathropteris meniscoides, Brong.=*C. reticulata.*
Taeniopteris vittata, Brong. (?).
Dictyophyllum serraticum, Kurr.
Pterophyllum longifolium, Brong.
,, *brevipenne*, Kurr.
,, *jaegeri*, Brong.
Desmiophyllum (*Phoenicopsis*) sp.
Voltzia coburgensis, Schaur.
Widdringtonites keuperianus, Kurr.

The Third and Lowest Horizon is that of the Lettenkohle from Stuttgart, Wurtzburg, and the Steigerwalde, which is equivalent to parts of the Middle and Lower Keuper and has yielded among others the following forms :—

Equisetites arenaceus (Brong.).
,, *platyodon* (Brong.).
Neocalamites meriani (Brong.).
Pecopteris rütimeyeri, Presl.
Danaeopsis marantacea, Presl.
,, *angustifolia* (Schen.).
Lepidopteris stuttgardiensis (Jaeg.).
Chiropteris digitata, Kurr.
Clathropteris meniscoides, Brong.=*C. platyphylla.*
Camptopteris serrata, Kurr.
Neuropteridium grandifolium, Schimp.
Sphenopteris schönleiniana (Presl).

Desmiophyllum (*Phoenicopsis*) sp.
Pterophyllum longifolium, Brong.
,, *brevipenne*, Kurr.
,, *jaegeri*, Brong.
Dioonites pennaeformis, Schen.
Zamites angustiformis, Bornem.
Voltzia coburgensis, Schaur.
Widdringtonites keuperianus, Heer.

Having in this way established "reference floras"—two for the Rhaetic, one for the Upper and one for the Lower Keuper—comparisons can now be made between them and the outside floras of Persia, Indo-China, and Japan, in which also Mesozoic marine beds overlie the plant-bearing zones.

4. PERSIA.

Between Teheran and the Caspian Sea such strata are involved in the folded chains of the Elburz Ranges. In the central parts of this region the fresh-water series, which is over 2000 feet in thickness, is overlain by strata with Middle Liassic ammonites, carries plants and coals in its lower portion, and rests upon a limestone which, though unfossiliferous, is supposed to be of Triassic age.*

From near Tasch and Kagwin Schenck † and Krasser ‡ have described floras, and from three other points to the north-west of Teheran Zeiller § has done the same, and in these lists are the following outstanding forms :—

Equisetites münsteri (Sternb.)	R.
Cladophlebis rösserti (Presl)	R. and L.
,, *nebbensis*, Brong.	R.
Asterotheca (*Pecopteris*) cf. *merani* (Brong.) .	K.
Taeniopteris tenuinervis, Brauns. . . .	R.
,, *spatulata*, M'cClell. (?)	*
Clathropteris meniscoides, Brong.=*C. platyphylla*	K. and R.
Pterophyllum aequale (Brong.)=*P. contiguum* (?).	R.
,, *braunianum*, Göpp.	R.
,, *tietzei*, Schen.	*
,, *münsteri*, Göpp.	R.
,, *bavieri*, Zeill.	*

* Stahl, 1911.
† Schenck, 1887.
‡ Krasser, 1891.
§ Zeiller, 1905; see also Seward, 1900, p. 38.

Podozamites lanceolatus (Lind. and Hutt.) . .	R. and L.
,, *distans*, Presl	K. and R.
,, *schencki*, Heer	K. and R.
Dictyophyllum cf. *nathorsti*, Zeill. . . .	*
Baiera münsteriana, Presl	R.
Nilssonia polymorpha, Schen.	R.
Cyparissidium nilssonianum, Nath. . . .	R.

(K=Keuper; R=Rhaetic; L=Liassic.)

The predominant character of this flora is unquestionably *Rhaetic*, a conclusion of great importance since this assemblage, with its admixture of Indo-Chinese forms (marked by an asterisk), provides a useful link between Europe and the East.

5. INDO-CHINA.

On the borders of Yun-Nan and Se-Tchouen, Le Clère * obtained plants from coal-bearing beds lying upon marine deposits of Middle Triassic age and overlain by a dolomitic limestone with casts of mollusca which Douvillé with hesitation has ascribed to the Liassic. The small collection of plants was discussed by Zeiller in a preliminary report † but more fully later on,‡ proving to be identical with the flora described by him from the coastal region near Tonkin.

The following might be noted :—

Cladophlebis (*Todites*) *rösserti* (Presl) . .	R.
Taeniopteris cf. *immersa*, Nath. . . .	R.
Clathropteris meniscoides, Brong.=*C. platyphylla*	K. and R.
Dictyophyllum exile, Brauns.	R.
Pterophyllum multilineatum, Shirley.	
Anomozamites inconstans, Göpp. . . .	R.
Glossopteris indica, Schimp.	

From the Tonkin area Zeiller § has recorded among others :—

Equisetites sarrani (Zeill.).	
Neocalamites carreri (Zeill.).	
Cladophlebis rösserti (Presl)	R. and L.
,, *nebbensis*, Brong.	R.
Pecopteris (*Asterotheca*) *cottoni*, Zeill.	
Danaeopsis cf. *hughesi*, Feist.	

* Le Clère, 1900, pp. 184, 592.
† Zeiller, 1900, p. 186.
‡ Zeiller, 1903, p. 291.
§ Zeiller, 1903.

Taeniopteris spatulata, M'cClell.	*†
,, *münsteri*, Göpp.	R.
,, *ensis*, Old.	†
,, *nilssonioides*, Zeill.	
,, cf. *immersa*, Nath.	R.
,, cf. *m'cClellandi*, Old. and Morr.	†
Ctenopteris sarrani, Zeill.	
Clathropteris meniscoides, Brong.=*C. platyphylla*	K. and R.
Dictyophyllum nathorsti, Zeill.	
Pterophyllum münsteri, Presl	R.
,, *aequale*, Brong.	R.
,, *contiguum*, Schen.	
,, *tietzei*, Schen.	*
,, *portali*, Zeill.	*
,, *bavieri*, Zeill.	*
Anomozamites inconstans, Braun.	R.
Ptilophyllum acutilobum, Morr.	†
Podozamites distans, Presl	R.
,, *schencki*, Heer	R.
Otozamites rarinervis, Feist.	†
Palaeovittaria kurzi, Feist.	
Glossopteris indica, Schimp.	
Noeggerathiopsis hislopi, Bunb.=? *Phoenicopsis*.	
Conites charpentieri, Zeill.	

(Those marked with an asterisk occur in Persia.)

The European species, to which can be added the few common to Persia, are all Rhaetic, while the alliances of the several *Dictyophyllums* are with Rhaetic forms and of the *Pecopterids* with Keuper species. The supposed Liassic affinities are almost entirely contributed by forms common or allied to those from the Rajmahal Beds of India, the age of which I consider as still *sub judice*, for example those marked with a dagger (†) in the above list.

Attention must, however, be drawn to several representatives of the Gondwana Flora characteristic of beds that are, from other lines of evidence, unquestionably of Triassic or even of Permian age, such as *Danaeopsis*, *Palaeovittaria*, and *Glossopteris*, while *Taeniopteris virgulata*, Zeill., is related to *T. feddeni* (Feist.) from the Damuda of India. The presence of these admittedly older forms troubled Zeiller,* whose analysis of the data was to the effect that these plants

* Zeiller, 1903, pp. 254–256.

possibly came from somewhat lower horizons, a conclusion which, while not improbably correct, is by no means assured; the occurrence of *Glossopteris* in the Molteno Beds, right up in Zone D, should not be overlooked. For the present it must be concluded that *the flora of Tonkin does not display any Liassic affinities, and, while covering the whole of the Rhaetic, probably extends back into the Triassic.*

Of importance in our inquiry are those non-European species common to the Stormberg Series of South Africa and the Ipswich Beds of Queensland that belong to the genera *Neocalamites, Taeniopteris,* and *Pterophyllum*, and that are of assistance in correlation. Remarkable therefore is the apparent absence of certain genera characteristic of these southern floras, for instance, *Thinnfeldia, Chiropteris, Ginkgoites, Stenopteris,* and *Pseudoctenis,* though the recent surprising discovery of a purely European Upper Carboniferous flora in Sumatra * ought to prepare us against the unexpected in the succeeding floral assemblages in these eastern regions.

6. JAPAN.

North of Yamanoi, in the province of Nagato,† plant beds overlain by marine Liassic strata have yielded the following, exclusive of purely Japanese species ‡ :—

Cladophlebis nebbensis, Brong.
Dictyophyllum nathorsti, Zeill.
Baiera paucipartita, Nath.
Podozamites lanceolatus (Lind. and Hutt.).

All four occur in the Rhaetic of Sweden, with which Yokoyama has correlated the strata. Elsewhere in Japan, at Nariwa § in the province of Bitchū, *Podozamites lanceolatus* has actually been found beneath beds containing the Upper Triassic (Noric) shell *Pseudomonotis ochotica,* Keys, so that this species cannot be regarded as indicative of a Jurassic age. Of this small flora it can be pointed out that *Cladophlebis nebbensis* occurs in the Molteno Beds, and that *Baiera paucipartita* is close to the South African *B. schencki.*

* Sahni, 1926, p. 243.
† Imp. Geol. Surv. Japan, Outlines Geol. Japan, 1902, p. 51.
‡ Yokoyama, 1905.
§ Imp. Geol. Surv. Japan, Geol. and Min. Res. Japanese Empire, 1926, p. 22.

7. CHILE.

The isolated flora of La Ternera,* north-east of Copiapó, occurs in fresh-water strata 50 metres in thickness, overlain in perfect conformity by beds with a Lower Liassic marine fauna, and can therefore be taken as of Rhaetic age without question. The forms described by Solms-Laubach, with some by Zeiller, include the following :—

Thinnfeldia lancifolia, Morr.
Chiropteris copiapensis, Solms.
Taeniopteris cf. *mareyesica*, Gein.
Clathropteris polyphylla, Brong. (?).
Dictyophyllum carlsoni, Nath.
Baiera münsteri, Presl.
,, *steinmanni*, Solms.
Linguifolium (*Leslya*) *steinmanni* (Solms).
Podozamites distans, Presl.
Palissya brauni, Endl.

The European elements support that opinion, while of importance is the presence of *Thinnfeldia lancifolia* and *Chiropteris copiapensis*, both of which occur in the Molteno Beds. It can be remarked that *Baiera steinmanni* is indistinguishable from *B. simmondsi* (Shirley) from the Ipswich Beds of Queensland. The genus *Leslya* is a palaeozoic one, and the species *L. steinmanni* has been placed by Arber † in his genus *Linguifolium* described from the Rhaetic of New Zealand.

8. ARGENTINA.

Groeber's investigations in the western part of this country have served to show that Lias or Dogger strata overlie the mainly volcanic assemblage in the Cordillera, closely associated with which in one or two localities are the plant-bearing beds in which the *Thinnfeldia* flora occurs. As the result of work in that region, I am ascribing the fossiliferous beds of Cacheuta, Barreal, Paramillo de Uspallata, Marayes, etc., to a position below the Rhaetic volcanics and believe they embrace part of the Upper Triassic as well as the Rhaetic.

The flora has been described by Geinitz,‡ Szajnocha,§ Kurtz,|| and others, though including many fragments quite unworthy of being named. A small collection made by the writer, and now in the South

* Solms-Laubach, 1899. † Arber, 1917, p. 36. ‡ Geinitz, 1876.
§ Szajnocha, 1888. || Kurtz, 1921–22.

African Museum, contains several new forms, which have been included in the following list, being marked by an asterisk :—

Neocalamites hörensis (His.) (Schimp.).
Schizoneura sp. . . . . *
Cladophlebis cf. *göppertiana* (Schen.) . . . *
,, cf. *sublobata*, Johann.
Cladophlebis (*Neuropteris*) *remota* (Presl).
Danaeopsis cacheutensis, Kurtz.
Thinnfeldia odontopteroides (Morr.).
,, *lancifolia* (Morr.).
,, *feistmanteli*, Johnst. . . . . . *
Chiropteris copiapensis, Solms . . . . *
Taeniopteris mareyesiaca, Gein.
,, *brackebuschiana* (Kurtz).
,, *carruthersi*, Ten.-Woods . . . . *
,, *m'cClellandi*, Old. and Morr. . . *
Pachypteris stelzneriana, Gein.
,, *lanceolata*, Brong. . . . . . *
Sphenopteris lobifolia, Morr.(?)=*Pecopteris schönleiniana.*
Stenopteris elongata (Morr.).
Ginkgoites (*Baiera*) *argentinae* (Kurtz).
Phoenicopsis elongatus (Morr.).
Zamites sp. . . . . *
Sphenolepis rhaetica, Gein.

With the exception of the Queensland and Tasmanian Floras this plant assemblage stands *nearer to that of the Molteno Beds* than any other, and it might be noted that the European element, which is still marked in the Chilian formation, now becomes relatively insignificant. Out of the above list twelve forms are represented in South Africa. The Museum of the University of Córdoba contains an immense quantity of material, which, when worked up, will doubtless bring to light many other common species.

III.—*ZONAL LIST OF SOUTH AFRICAN PLANT SPECIES.*

The following is the complete list of the forms from the Upper Beaufort and the Molteno Beds of the Union and of those from the Forest Sandstone Series of Southern Rhodesia, the latter being distinguished by an asterisk :—

	Upper Beaufort.		Molteno.			Red Beds.
	Zones.					
	A.	B.	C.	D.	E.	F.
EQUISETALES.						
Equisetites cf. *platyodon* (Brong.)				×		
,, spp.		×				
Neocalamites carreri (Zeill.)		×	×	×	×	
Schizoneura sp. *a*, Sew.		×				
,, sp. *β*, Sew.					× ?	
FILICALES.						
Cladophlebis concinna (Presl)				×		
,, *nebbensis*, Brong.				×		
,, (*Todites*) *göppertiana* (Schen.)				×		
,, ,, *rösserti*, (Presl)			×			
Marattiopsis münsteri (Göpp.)				×		
Danaeopsis hughesi, Feist.	×	×				
Chiropteris cuneata (Carr.)				×		
,, *zeilleri*, Sew.				×		
,, *copiapensis*, Solms				×		
Sagenopteris longicaulis, sp. nov.				×		
,, sp.		×				
**Thinnfeldia odontopteroides* (Morr.)		×	×	×	×	
* ,, *lancifolia* (Morr.)		×	×	×		
* ,, *feistmanteli*, Johnst.		×	×	×		
,, ,, var. *trilobita*			×			
,, *rhomboidalis*, Ett.			×			
,, *acuta*, Walk.		×	×	×		
,, *narrabeenensis*, Dun (MS.)			×			
Lepidopteris stuttgardiensis (Jaeg.)		×				
FERN-LIKE PLANTS AND PLANTS OF UNCERTAIN POSITION.						
*? *Taeniopteris carruthersi*, Ten.-Woods			×	×		
,, cf. *immersa*, Nath.				×		
,, *nilssonioides*, Zeill.		×		×		
,, *brackebuschiana*, Kurtz			×	×		
,, *crassinervis* (Feist.)			×			
* ,, *m'cClellandi* (Old. and Morr.)						
,, *lata*, Old.		×				
,, *magnifolia*, Rogers		×				
,, *spatulata*, M'cClell.			×	×		
Pachypteris acuta, sp. nov.			×	×		×
,, *lanceolata*, Brong.						
,, *incisa*, Sap.			×	×		
Stormbergia gardneri, Sew.				×		
Sphenopteris lobifolia, Morr.				×		
Stenopteris elongata (Carr.)		× ?	×	×		
,, *densifolia*, sp. nov.				×		
Callipteridium stormbergense, Sew.			×	×		
,, *africanum*, sp. nov.		×		×		
Odontopteris browni, Sew.		×				
Johnstonia coriacea, Walk.				×		
Glossopteris browniana, Brong.				×		
,, *conspicua*, Feist.				×		
Phoenicopsis elongatus (Morr.)			×	×		
*Cf. *Pleuromeia*.						

	Upper Beaufort.		Molteno.			Red Beds.
	Zones.					
	A.	B.	C.	D.	E.	F.
GINKGOALES.						
Ginkgoites digitata (Brong.)				×		
,, *antarctica* (Sap.)				×		
,, *moltenensis* (Sew.)				×		
,, *magnifolia* (Font.)		×		×		
Baiera schencki, Feist.			×	×		
Stachyopitys sp.				×		
CYCADOPHYTES.						
Zamites cf. *rajmahalensis* (Morr.) . .		×		×		
Pterophyllum multilineatum, Shir. . .				×		
,, cf. *braunianum*, Göpp. . .				×		
,, cf. *tietzei*, Schen. . . .		×				
,, (*Anomozamites*) *inconstans* (Braun)				×		
Moltenia dentata, gen. et sp. nov. . .				×		
,, sp.				×		
Pseudoctenis cf. *balli* (Feist.) . . .			×			
,, *carteriana* (Old.) . . .				×		
,, *fissa*, sp. nov. . . .			×			
,, *spatulata*, sp. nov. . . .				×		
,, *lanciformis*, sp. nov. . .				×		
,, *capensis*, sp. nov. . . .				×		
Nilssonia browni, sp. nov.		×				
CORDAITALES.						
Dadoxylon sclerosum, Walt. . . .					×?	
* ,, sp.	×	×	×	×	×	×
**Rhexoxylon africanum*, Bancr. . . .						×
,, *tetrapteridoides*, Walt. . .				×		
,, *priestleyi* (Sew.) . . .				×		
,, sp.		×				
CONIFERALES.						
Voltzia cf. *liebeana*, Gein.				×		
Conites charpentieri, Zeill.				×		
Elatocladus sp.				×		
**Cyparissidium* cf. *nilssonianum*, Nath. .						
Stigmatodendron dubium, Sew. . . .		×				
Strobilites laxus, Sew.		×				

IV.—*THE AGE AND CORRELATION OF THE UPPER KARROO BEDS.*

Having in this manner analysed the various extra-African plant assemblages, the stratigraphical positions of which are determinable by the associated marine mollusca to within narrow limits, and having

thus established our "reference floras," we are now in the position of being able to discuss the question of the relationships and age of the Upper part of the Karroo System. It might be pointed out that the number of those European, Asian, or South American species that can so be employed represents not far from one-half of the total South African flora, which proportion is considered to be sufficient for the purpose in view. Further collecting should undoubtedly enable a much closer correlation to be made in the near future.

I. The Upper Beaufort Beds. Zones A and B.

Of the relatively small "northern" element, *Taeniopteris magnifolia* is represented in the Triassic—Lower Keuper—of Virginia, *Lepidopteris stuttgardiensis* is a Middle Keuper form, *Pterophyllum tietzei*, with which the Aliwal North plant has been compared, is from the Rhaetic of Persia, while *Danaeopsis hughesi* is close to *D. marantacea* from the Upper, Middle, and Lower Keuper. *Callipteridium* and *Odontopteris* are characteristic Palaeozoic genera, while *Stigmatodendron* has been compared with Palaeozoic forms, and *Strobilites* with Permian and Triassic types.

The formation is undoubtedly Triassic, with probably an age not younger than Lower or at the latest Middle Keuper, which conclusion is in close conformity with the evidence from the accompanying vertebrates. Seeing that these plants all come from the *uppermost section*, Zone B, of the Beaufort Beds, it is likely that the base of the Upper Beaufort group will range down into the Bunter—Lower Triassic—which opinion finds support from the affinities of the reptilian and amphibian remains therein.

The above determination has an important consequence by suggesting a Keuper age for the basal Zone C at least of the overlying Molteno Beds.

II. The Molteno Beds. Zones C and D.

From the foregoing lists there is no doubt that the majority of the Eurasian species—mainly fern-like plants and ginkgoales—are *Rhaetic*, for example :—

Cladophlebis rösserti, *C. nebbensis*, *C. göppertiana*, *C. concinna*, *Marattiopsis münsteri*, *Thinnfeldia rhomboidalis*, *Taeniopteris immersa*, *T. crassinervis*, *Pterophyllum* (*Anomozamites*) *inconstans*, and *P. braunianum*, though *P. multilineatum* is allied to *P. longifolium* from the Keuper. *Ginkgoites antarctica* and *G. digitata* occur chiefly in the

Liassic, but the latter is actually known from the Permian of Angaraland. *Pachypteris lanceolata* is also a Liassic form, but is present in beds in Argentina certainly not younger than Rhaetic. *Sagenopteris longicaulis* is very close to *S. undulata* from the Rhaetic of Sweden. In a few other cases where specific identity is not possible the alliances are generally with Rhaetic forms, for instance *Baiera schencki*.

The *Triassic* element is represented by *Equisetites platyodon*, a Keuper species, while, although the three species of *Chiropteris* are none of them European, the genus belongs to the Middle and Lower Keuper. *Thinnfeldia narrabeenensis* is a form belonging to the lower portion of the Hawkesbury Series of New South Wales, which from other lines of evidence must be low down in the Triassic.

There is, moreover, quite an important *Permian* element composed largely of pteridosperms, together with some cycadophytes and plants of doubtful position, partly European, partly belonging to the Glossopteris Flora.

Callipteridium is a Palaeozoic genus, not known to occur in the northern hemisphere in post-Bunter strata. *Voltzia liebeana* is an Upper Permian species, while *V. heterophylla*, with which the Molteno plant can also be compared, is common in the Bunter. *Sphenopteris lobifolia* occurs in the Lower Permian of Australia, and is allied to Permian species of Saxony. *Pseudoctenis balli* is a member of the Barakars of India and accordingly Lower Permian.

The presence of *Glossopteris* is of great interest, the only other determinable example known from the Molteno Beds being the small pinnule of *G. browniana*, V. 3256, preserved in the British Museum, from near Molteno * in Zone D. *G. browniana* is known to have had a long range in Gondwanaland, at least into the Lower Triassic, but only in Indo-China and South Africa has it been found associated with the Thinnfeldia Flora, in the first-named at perhaps a slightly lower horizon, if Zeiller's surmise is correct, but in the Cape and Natal actually in Zone D. In Australia the genus is not known to have survived the Permian. *G. conspicua*, on the contrary, is a species not known hitherto above the upper portion of the Lower Beaufort Beds of Natal nor the Raniganj of India, both formations belonging to the very top of the Permian.

It will hence be seen that the flora of the Molteno Beds shows an anomalous mixture of, (*a*) Eurasian Rhaetic genera and species, (*b*) European Keuper types, (*c*) European Permian elements, and

* Arber, 1905, p. 61.

(*d*) representatives of the Glossopteris Flora with Permo-Triassic characters.

Bearing in mind the remarks made on p. 299, it is difficult to countenance the extreme position that the flora is definitely Rhaetic with a very appreciable number of survivals from the Palaeozoic. Rather would the affinities appear to justify the more reasonable view that the assemblage is essentially *older*, in the main early Mesozoic, but with certain Permian survivals, and that the Eurasian Rhaetic elements made an earlier appearance here than in the Northern Hemisphere, and hence probably originated in Gondwanaland. It is significant that similar anomalies should be displayed in the Thinnfeldia Floras of both Indo-China and Australia—areas that must have formed parts of the Gondwana Continent in the early Mesozoic.

Palaeontological studies have all been tending very definitely to show the probable South African ancestry of certain of the Triassic vertebrata of Europe, while in return the saurischia and pseudosuchia of the Red Beds and Cave Sandstone embrace genera known from the Keuper-Rhaetic of Germany. An interchange of terrestrial vertebrate life between Europe and Gondwanaland is clearly denoted, and by analogy floral migrations might be anticipated. Doubtless such exchanges were not quite free, for many characteristic Trias-Rhaetic plants of the Northern Hemisphere are as yet unknown in South Africa, for example *Clathropteris*, *Camptopteris*, *Scolecopteris*, *Dictyophyllum*, and *Otozamites*.

It might be remarked that the period of crustal stability in Gondwanaland appears to have terminated at about the end of the Palaeozoic, that important earth movements affected that continent in the early part of the Triassic, and that the revolutionary changes in the characters of its plant life could be connected with such geographical vicissitudes.

Reviewing the evidence, it would seem more probable that the Molteno Flora must be regarded as *essentially of Upper Triassic—Keuper—age*, but containing an element of Permian aspect derived from the north, an element from the local Glossopteris Flora, and a fairly large fraction, mostly filicales and ginkgoales, which migrated northwards to form a component of the Rhaetic assemblages of the Northern Hemisphere.

The forms from Zones E and F are insufficient to enable any opinion to be instituted, but the vertebrate remains suggest an age for the Red Beds and Cave Sandstone *not younger than Rhaetic*.

III. Comparisons with the other Thinnfeldia Floras.

The persistence of Gondwanaland as a continent to about the Jurassic receives a good deal of support from the close floral resemblances of the Trias-Rhaetic formations of the several units—India, Indo-China, Australasia, and Argentina.

INDIA.

With the Upper Beaufort group can be paralleled the Parsora Stage,* the uppermost of the Lower Gondwanas, with *Glossopteris, Danaeopsis*, and *Schizoneura.*

The alliances of the Molteno Beds, on the other hand, are more with the Rajmahal Beds,† Upper Gondwana, common species being *Cladophlebis concinna, Taeniopteris crassinervis, T. lata, T. spatulata, T. m'cClellandi* (from the Somabula Beds of Rhodesia), *Pseudoctenis* (*Pterophyllum*) *carteriana*, and *Zamites* (*Pterophyllum*) *rajmahalensis*, while *Pterophyllum propinquum* is close to *P. multilineatum.*

A provisional list, which Dr. B. Sahni has very kindly sent me, reveals a large number of forms with Jurassic affinities, which would appear to confirm the opinions, never until now questioned, as to a post-Rhaetic age for the Indian formation, but the discovery of these common species raises a doubt as to the age of the Rajmahal Beds. The plants are reported to come from sedimentary intercalations on several levels in a group of volcanics fully 2000 feet in thickness, and I am informed that the fossils described come from more than one distinct horizon. Until this matter has been decided nothing further can be done, but the resemblances noted here strongly suggest that the Rajmahal Beds may possibly include in their lower zones an horizon not younger than Rhaetic.

INDO-CHINA.

The number of common species is quite appreciable, for example :—‡

Neocalamites carreri, Cladophlebis rösserti, C. nebbensis, Marattiopsis münsteri, Taeniopteris immersa, T. nilssonioides, T. m'cClellandi (from the Somabula Beds of Southern Rhodesia), *Pterophyllum multilineatum, Conites charpentieri*, and *Glossopteris browniana*, var. *indica.*

* Sahni, 1922.

† Oldham and Morris, 1863; Feistmantel, 1877.

‡ Zeiller, 1903.

Curiously, *Thinnfeldia* and *Ginkgoites* are absent, but the latter is not represented in India either.

It is probable that the lower horizons in Tonkin extend down into the Upper Triassic.

QUEENSLAND.

In the Ipswich Series there are many common species and also a number of allied forms, for instance :—*

Neocalamites carreri, *Schizoneura* sp. *a*, *Taeniopteris carruthersi*, *T. crassinervis*, *T. spatulata*, *Chiropteris cuneata*, *Thinnfeldia odontopteroides*, *T. lancifolia*, *T. acuta*, *T. feistmanteli*, *Stenopteris elongata*, *Ginkgoites digitata*, *G. antarctica*, *G. magnifolia*, *Phoenicopsis elongatus*, and *Pterophyllum multilineatum*, while *Taeniopteris tenison-woodsi* is close to *T. brackebuschiana*, *Baiera bidens* to *B. schencki*, and *Schizoneura africana* is a Lower Beaufort form.

There can be hardly any doubt that the Ipswich Beds are the precise equivalent of the Molteno Beds.

NEW SOUTH WALES.

The number of common species with the Hawkesbury Series is less, largely no doubt because the flora of the latter is not so well known.† One finds only *Taeniopteris crassinervis*, *Thinnfeldia odontopteroides*, *T. lancifolia*, *T. feistmanteli*, and *T. narrabeenensis*, while *Pachypteris incisa* may perhaps be the same as *Gleichenia dubia*.

TASMANIA.

The list of common species is very nearly the same as with the Ipswich Series, for example :—‡

Neocalamites carreri, *Taeniopteris carruthersi*, *Thinnfeldia odontopteroides*, *T. lancifolia*, *T. feistmanteli*, and var. *trilobita*, *Johnstonia coriacea*, *Ginkgoites digitata*, *Phoenicopsis elongatus*, and *Pterophyllum* (*Anomozamites*) *inconstans*, while *Chiropteris tasmanica* is allied to *C. cuneata*.

ARGENTINA.

The list of species is almost as large :—

Cladophlebis göppertiana, *Chiropteris copiapensis*, *Thinnfeldia odontopteroides*, *T. lancifolia*, *T. feistmanteli*, *Taeniopteris carruthersi*,

* Walkom, 1915, 1917, 1917*a*, 1924. † *Ibid.*, 1918, 1925.

‡ *Ibid.*, 1925, 1925*a*.

T. brackebuschiana, Stenopteris elongata, Pachypteris lanceolata, T. m'cClellandi (Southern Rhodesia), and *Sphenopteris lobifolia.*

The strata are hence equivalent with the Molteno Beds.

MADAGASCAR.

In comparing floras, the importance of this island so close to South Africa is apt to be overlooked. Zeiller * has determined the following forms from beds that can be regarded as of Triassic age, and the representatives of the Upper Karroo :—

Cladophlebis (*Neuropteris*) *remota,* known from the Upper Keuper and from the beds of Argentina ; a pinnule like *Taeniopteris magnifolia* from the Triassic—Lower Keuper—of Virginia ; a frond like *Lepidopteris stuttgardiensis* and a pinnule like *Danaeopsis marantacea* from the Keuper of Germany ; *Voltzia heterophylla* and *Schizoneura paradoxa,* both Bunter species ; and *Noeggerathiopsis lacerata,* a form belonging to the Karharbari Beds of India ; while *Glossopteris indica* occurs at a somewhat lower horizon, though all the plants come from within 100 metres of the base, which rests on crystalline rocks.

V.—*SYSTEMATIC DESCRIPTIONS—THE MOLTENO FLORA.*

A.—EQUISETALES.

Genus EQUISETITES, Sternberg.

Equisetites cf. platyodon (Brongniart).

Plate XVI, fig. 1.

1821. *Equisetites conicus,* Sternberg, Flor. der Vorwelt, vol. ii, p. 44, pl. xvi, fig. 8 ; pl. xxx, fig. 1.

1865. *Equisetum platyodon,* Schönlein and Schenck, Abbild. foss. Pflanz. Keuper Frankens, pl. v, figs. 1, 2 ; pl. vi, figs. 5, 6.

1898. *Equisetites platyodon,* Seward, Fossil Plants, vol. i, p. 267, fig. 59.

In the small fragment, 8330, from the Molteno Beds near the town of Dordrecht, which is nearly 2 cm. wide, the surface was formed of friable coaly material, which on removal displayed the imprint figured here. It is the only example from South Africa in which the impression is

* Zeiller, 1911.

still preserved of the leaf-sheath, fused and closely adhering to the stem and ending in short free teeth only 2 mm. long, contracting abruptly and terminating in fine narrow points. Their number on the flattened stem is 18, which would denote about 36 in all.

Of the few species with which comparison can be made, the only one with any strong resemblance is *E. platyodon*, from the Middle Keuper of Germany, which has about the same number of short, pointed teeth, and the Molteno plant could well represent a branch of this well-known Triassic species. It differs appreciably in the number and length of the teeth from *E. münsteri*, *E. columnaris*, and *E. lateralis*.

Genus NEOCALAMITES, Halle.

Neocalamites carreri (Zeiller).

(Plate XVI, figs. 2, 3.)

1903. *Schizoneura krasseri*, Seward, Ann. S. Afr. Mus., vol. iv, pt. 1, p. 48, pl. ix, figs. 5, 6.

1903. *Schizoneura carreri*, Zeiller, Flore foss. Tonkin, p. 137, pls. xxxvi–xxxviii.

1908. *Schizoneura carreri*, Seward, Quart. Journ. Geol. Soc., vol. lxiv, p. 85, pl. ii, fig. 1.

1908. *Neocalamites carreri*, Halle, Kungl. Svensk. Vetens. Akad. Handl., 43, p. 6.

1915. *Neocalamites carreri*, Walkom, Queensl. Geol. Surv., Publ. 252, p. 34, pl. 1, figs. 1, 4.

Quite common in the Molteno Beds is this form, which was described by Seward as *Schizoneura krasseri*, and subsequently identified by him with Zeiller's *S. carreri* from the " Rhaetic " of Tonkin, but which, following Halle's classification, would now be put in the genus *Neocalamites*. Among the new material are several examples worthy of being described, since they reveal much more of the structure of this plant than do the moulds of the stem-interior, to be usually collected.

From the Molteno Beds, near Fletcherville, East Griqualand, come not only flattened stems, but others that are embedded in hard, grey, fine-grained sandstone in a vertical position, their interiors being filled with a calcareous sandstone, though it is probable, as Seward has pointed out in discussing similar instances, that the stems drifted and then sunk, rather than that they grew *in situ*. In the process

of becoming filled the diaphragms have in certain instances been torn away from the inner wall of the stem, and are therefore warped. During the consolidation of the sediments appreciable compression in a vertical plane must have occurred, which would explain the small internodal distance as compared with the diameter of the stem. Such is about 1·5 cm., while the oval cross-sections are from 4 to 8 cm. across. In an accompanying large, flattened stem, which is almost 9 cm. wide, the internodal distance is actually 3·7 cm.

As shown in the drawing of 8329, Plate XVI, fig. 2, the leaves are disposed in a whorl, radiating outwards in an almost horizontal plane around the node, and, where broken off, small nearly circular scars mark their points of attachment. The internodal surface shows shallow flutings on its exterior, and is very finely striated, while development of the interior proves the inner wall to possess corresponding, but sharper, grooves, such as would give rise on casts of the interior to narrow longitudinal ridges of the kind well known in *Neocalamites.* The under surface of the nodal diaphragm showed in one case, 258t, faint radial striations.

The whorl gives one the impression of a continuous collar to a distance of a few millimetres before breaking up into the narrow free teeth, and the specimens were for some time taken as belonging to the genus *Phyllotheca,* and were compared with *P. equisetitoides,* Schmal., from the Permian of Siberia, with which they have a very strong resemblance. This feature is apparently due to the mutual overlapping of the leaf bases, which expand at their points of attachment, and doubtless the leaves are free throughout their lengths. Their number is about 60, 2 to 5 mm. wide at the base, concave above, and they show either one strong vein with subsidiary fine veins, or else two prominent outer veins with fine veins between, and radiate outwards to a distance of certainly more than 5 cm. in particular cases.

These vertically-set stems therefore display a marked Annularia-like habit, and both in this respect and also in having short internodes the plant strongly resembles Berry's species *Neocalamites knowltoni* * from the Keuper of Virginia, which has, however, much fewer leaves in each whorl. It is clear too that the South African stems could not have been very different from their Palaeozoic ancestors, the Calamarieae.

A second example, 5806, from near Dordrecht is reproduced in Plate XVI, fig. 3, since it shows the exterior of the stem, with a shallow

* Berry, 1912, p. 174, pl. xvii; 1918, p. 445, figs. 1, 2.

fluted surface traversed by extremely fine striations, while the leaf scars, about 18 in the width of 4·5 cm., are situated immediately beneath the nodal line.

In a third example, 8316, from the black shales at Duart Castle, Hlatimbe Valley, Natal, one sees crushed upon the cast of the stem the oval impression of a nodal diaphragm radially striated, while adjacent thereto are striated moulds with the ridges and grooves continuous in their course from one internode to the next, a feature characteristic of *Neocalamites.*

All these examples can be ascribed without hesitation to *N. carreri*, duplicating many of the features of Zeiller's illustrations, which species has also been recorded by Walkom from the Ipswich Beds of Queensland. They have also a great similarity to *N. hörensis* (Schimp.) from the Lower Lias of Sweden,* but in which the internodal distance is much greater than the breadth of the stem, whereas in the Molteno plant the reverse is common; the latter is also close to *N. meriani* (Brong.) from the Keuper of Germany.†

Genus SCHIZONEURA, Schimper and Mougeot.

Schizoneura sp. β, Seward.

1908. *Schizoneura* sp. β, Seward, Quart. Journ. Geol. Soc., vol. lxiv, p. 86, text-fig. 1.

No further examples are forthcoming of this curiously constricted pith-cast, and there is nothing more to add to Seward's description. The original comes from the Stormberg Beds of Basutoland, from an unknown horizon, which cannot, however, be lower than the Molteno Beds.

B.—FILICALES.

Genus CLADOPHLEBIS, Brongniart.

Cladophlebis (Todites) rösserti (Presl).

1908. *Cladophlebis* (*Todites*) *roesserti*, Seward, Quart. Journ. Geol. Soc., vol. lxiv, p. 98, pl. viii.

(For synonymy see Zeiller, Flore foss. Tonkin, 1903, p. 38.)

The specimen, from the extreme base of the Molteno Beds on the Indwe River, was assigned by Seward to this species, although the

* Halle, 1908, p. 6, pls. 1, 2.

† Schimper, 1874, pl. xv, figs. 1–3; pl. xvi, fig. 5.

pinnules are shorter and broader than in those examples that have been described under this name. Zeiller has placed under *C. rösserti* the species *C. göppertiana*, which I consider shows sufficient differences to be regarded as distinct therefrom, and which will be dealt with below

Cladophlebis concinna (Presl).

Plate XVII, fig. 1.

1838. *Pecopteris concinna*, Presl in Sternberg, Flora d. Vorw., vol. ii, p. 149, pl. xl, figs. 3*a*, *b*.
1868. *Pecopteris concinna*, Schenck, Foss. Flora Grenzsch., p. 56, pl. xiii, fig. 2.
1881. *Pecopteris concinna*, Feistmantel, Palaeont. Indica. Gond. Flora, vol. iii, p. 82, pl. xvii A, figs. 1–6.

The specimens 5911 and 6198, from the Molteno Beds of Konings Kroon, Elliot, are uncommon in that, unlike all other remains from this formation, they are portions of skeletal fronds having the outlines of the pinnules and the lamina only showing up here and there as whitish impressions on the grey stone; the lamina must therefore have been extremely thin.

The fronds are bipinnate at least, pinnae alternate, while the pinnules are ovate, much rounder than is usual in *Cladophlebis*, not much longer indeed than broad, set closely together and sometimes overlapping, attached by the whole of the base, convex on the side of the rachis, with base slightly indented, and with the opposite side also convex, but not to the same degree. The basal pinnules are nearly opposite, the upper ones alternate, while in the apical part of a pinna the lobes are united; in certain of the apices the impression of the lamina is quite distinct. The veins are strong, and the primary one goes out at an oblique angle from the rachis, is sinuous and slightly decurrent, while the secondary veins—relatively few in number—proceed outwards at a moderate angle, fork once only in their length, and do not bifurcate again as is mostly the case in *Cladophlebis*.

The impressions agree well with the form originally described by Presl as *Pecopteris concinna* from the Rhaetic of Bamberg in Germany, and also recorded by Feistmantel from the Panchet Series of India in the Raniganj Coalfield. The Indian examples show the same peculiarity in having a delicate lamina, which has led to their preservation in the skeletal condition, but the veins are more numerous, though only forking once. The original description by Presl, together

with Schenck's figure, clearly shows that the species in question should not be placed under *Pecopteris*, wherefore, since the fronds are all sterile, it becomes advisable to remove them to the genus *Cladophlebis*, instituted for infertile Mesozoic fronds of this character.

The South African plant, which can accordingly be regarded as *C. concinna*, differs from all the common species of *Cladophlebis* of the Trias-Jura, in which the pinnules are elongated and generally somewhat falcate. It shows, however, resemblances to *C. ovata*, Fontaine,* from the Triassic of Virginia, in which the shape, arrangement, and venation of the pinnules are very similar, but with the lamina thick and the rachis very stout.

Cladophlebis (Todites) göppertiana (Schenck).

Text-figure 1.

1867. *Acrostichites göppertianus*, Schenck, Foss. Flora Grenzsch., p. 44, pl. v, figs. 5, 5*a*; pl. vii, figs. 2, 2*a*.

The example, 8262, of a bipinnate frond from the Waterfall, Upper Umkomaas Valley, Natal, having long linear pinnae set nearly at right angles to the slender rachis differs from almost all *Cladophlebis* fronds in the unusual shape of the pinnules, which, instead of being attached by the full width of the base, show a decided contraction on the adaxial side thereof, though slightly decurrent, as indicated in the enlargement.

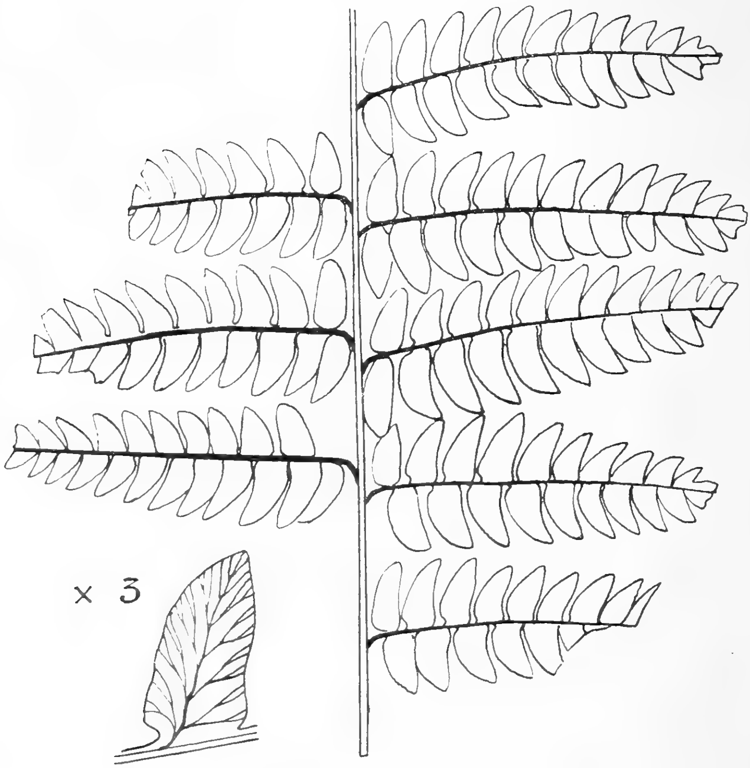
In the two basal pinnules this contraction is not only more marked but affects both edges. The pinnules are evenly graded as to size, have smooth margins, and are falcate, the side towards the rachis being strongly bulged, the other one concave, characters that are more marked in the apical pinnules, which furthermore tend to be in close contact and decurrent. The primary vein is not central, but is nearer the adaxial side, and gives off secondary veins, which divide twice in the regular *Cladophlebis* manner.

Excepting that its rachis is not so stout, and that the pinnae are set at a wider angle thereto, the Natal form is identical with the plant from the Rhaetic Beds of Bayreuth, described by Schenck as *Acrostichites göppertianus*. It is also rather like *Cladophlebis* (*Todites*) *williamsoni*, more particularly the variety *tenuicaulis* described by Thomas † from the Jurassic of Russia. The fertile pinnules figured

* Ward, 1900, p. 50, pl. xxvi, fig. 5; pl. xxvii, fig. 3.

† Thomas, 1911, p. 69, pl. iii, figs. 12, 12*a*.

by Schenck bear their sporangia over the whole lower surface of the lamina in the manner of the Osmundaceae, and that form can therefore be placed under *Todites*. The sterile Natal plant can accordingly be designated *C.* (*Todites*) *göppertiana* in order to reveal this particular relationship. Fronds identical with the form described are represented



TEXT-FIG. 1.—*Cladophlebis* (*Todites*) *göppertiana* (Schen.).

in the South African Museum collections, obtained from the "Rhaetic" of Cacheuta (Nos. 7108, 7110, 7112, 7113) and of Barreal (No. 7137), Argentina.

Comparison can also be instituted with *C. spectabilis* (Heer), from the Jurassic of Oregon,* and to a less marked degree with *C. linnaeaefolius* (Bunb.), from the Triassic of Virginia.†

* Ward, 1900, p. 345, pl. xlix, figs. 4, 5.

† Fontaine, 1883, p. 25, pl. vi, fig. 3; pl. vii, figs. 1–4; pl. viii, fig. 1; pl. ix, fig. 1.

CLADOPHLEBIS NEBBENSIS (Brongniart).

Text-figure 2.

1837. *Pecopteris nebbensis*, Brongniart, Hist. Végét. foss., vol. i, p. 299, pl. xcviii, fig. 3.

1876. *Cladophlebis nebbensis*, Nathorst, K. Vet. Akad. Handl., Bd. 14, No. 3, p. 16, pl. ii, fig. 1–6; pl. iii, fig. 1–3.

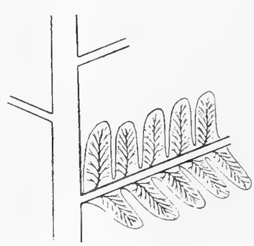
1889. *Alethopteris* sp. (cf. *Asplenium nebbense*), Feistmantel, Karroo Formation, p. 68, pl. ii, figs. 12, 12*a*.

1903. *Cladophlebis nebbensis*, Zeiller, Flore foss. Tonkin, p. 45, pl. iv, figs. 2–4.

1905. *Cladophlebis nebbensis*, Yokoyama, Journ. Sci. Imp. Univ. Tokyo, vol. xx, pt. 5, p. 3, pl. i, figs. 1–3.

A fragment from Indwe had in 1889 been described by Feistmantel as probably belonging to this interesting species, in which he was right, for the discovery of larger portions of a frond, 8646, unfortunately somewhat crushed and broken, at Tarka near Indwe, enables this plant to be identified with certainty. This shows part of a bipinnate frond with stout, finely striated rachis, centrally grooved, and bearing pinnae set at a wide angle.

The pinnules have nearly parallel margins and a bluntly pointed apex, and are 8–9 mm. long and about 3 mm. broad, attached by the whole of the base, and curving gently forward towards the apex of the pinna. The strong secondary veins have produced a kind of wrinkling, which causes the margins to appear slightly indented, though they are actually smooth. With some difficulty it is possible to make out that the lower basal pinnule is somewhat smaller, and the upper basal one somewhat larger, than the remaining pinnules. The primary vein is slightly decurrent, while the secondary veins are given off abruptly therefrom at a fairly wide angle, and only fork once, fig. 2.



TEXT-FIG. 2.—*Cladophlebis nebbensis* (Brong.).

These several characters, particularly the singly dichotomising secondary veins and the disproportionate size of the two basal pinnules, suffice to establish this plant as *C. nebbensis*, as will be seen from Zeiller's excellent review of this typically Rhaetic species, which has been recorded from Sweden, Persia, Tonkin, and Japan.

A second example, 174f, from the farm Clutha, Tsomo River, Elliot, can also be ascribed to this species.

Genus MARATTIOPSIS, Schenck.

Marattiopsis münsteri (Göppert).

Plate XVIII, figs. 1, 2.

1836. *Taeniopteris münsteri*, Göppert, Gatt. Foss. Pfl., Lief 3, 4, p. 51, figs. 1–3.
1868. *Taeniopteris münsteri*, Schenck, Foss. Flora Grenzsch., p. 99, pl. xx, figs. 2–8.
1869. *Angiopteridium münsteri*, Schimper, Traité Paléont. Végét., vol. i, p. 603, pl. xxxviii, figs. 1–8.
1900. *Angiopteridium californicum*, Fontaine, Twentieth Ann. Rep. U.S. Geol. Surv., pt. 2, p. 351, pl. lv, figs. 2–5.
1903. *Taeniopteris* (*Marattia*) *münsteri*, Zeiller, Flore foss. Tonkin, p. 63, pl. ix, figs. 6–8.
1910. *Marattiopsis münsteri*, Seward, Fossil Plants, vol. ii, p. 408, fig. 245, D, E.

The leaf, 8324, figured from the Molteno Beds of the Waterfall, Upper Umkomaas Valley, Natal, would appear to belong to this genus rather than to *Taeniopteris*, as is suggested among other things by the fact that the mid-rib divides the lamina into two parts that are not of strictly equal widths. The leaf, though wanting the base, is 8 cm. long and is 1 cm. broad in its proximal portion and 1·5 cm. at its spatulate apex. The view is from the under surface and reveals a very prominent and raised mid-rib, which is well developed right up to the apex and on which occur many closely set, tiny protuberances, the bases very probably of hairs or minute spines. The secondary veins emerge at a wide angle and run almost at right angles to the mid-rib, either in simple fashion or bifurcating—usually on leaving the primary vein—to the edges, where they terminate against a clearly defined marginal vein ; at the apex of the pinnule they curve forwards slightly. The number of veins near the edge is about 16 per cm.

The leaf is indistinguishable from the well-known species *M. münsteri* of the Rhaetic of Germany,* Sweden,† and Tonkin,‡ and can with

* Nathorst, 1878*a*, p. 48, pl. i, fig. 6.

† Schimper, 1869, p. 603, pl. xxxviii, figs. 1–6 ; Schenck, 1868, p. 99, pl. xx, figs. 2–8.

‡ Zeiller, 1903, p. 63, pl. ix, figs. 6–8.

little doubt be referred thereto. There are, however, no traces of synangia near the ends of the veins, such as are known to occur on the fertile pinnules belonging to that plant.

A portion of a bluntly pointed and more tapering pinnule from the town of Maclear, 8328a, has the mid-rib asymmetrically situated and a similar venation, and can provisionally be referred to this genus, and may perhaps belong to the species *M. münsteri.*

FILICALES—OPHIOGLOSSALES.

Genus CHIROPTERIS, Kurr.

Chiropteris cuneata (Carruthers).

Text-fig. 3, A, B.

1872. *Cyclopteris cuneata*, Carruthers, Quart. Journ. Geol. Soc., vol. xxviii, p. 355, fig. 5.

1899. ? *Anthrophyopsis* sp., Feistmantel, Abh. k. böhm. Ges. Wiss., Folge vii, Bd. iii, p. 67, pl. ii, fig. 4.

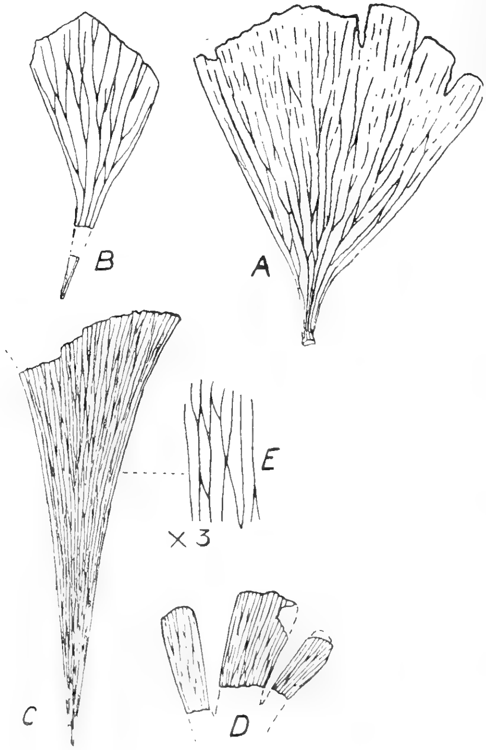
1903. *Chiropteris cuneata,* Seward, Ann. S.A. Mus., vol. iv, pt. i, p. 62, pl. ix, fig. 4.

The leaf from Cyfergat described by Seward is refigured in A, further development of the slab having exposed the base of the pinna and the petiole, the last-named not being known in the type in the British Museum, which is from the Ipswich Series of Queensland. The view of the lamina is evidently from below, for the contracted portion shows a medial groove, while the petiole, curving a little to one side, turns up from the slab. Another example also shows these features. Not improbably the pinnae were sessile and were either attached to the two sides of a rachis or borne in a verticil, radiating outwards nearly horizontally from the stalk, as suggested by some *Chiropteris* fronds from Scania.

The dissected character of the outer margin on the right is apparently natural, and is thus comparable to the lobing in *C. lacerata,* Arber,* from the Rhaetic of New Zealand; on approaching this margin the veins bifurcate simply. The affinities have been discussed by Seward and it can only be added that the otherwise comparable small *C. tasmanica* described by Walkom † from the Mesozoic of Tasmania has a rounded margin.

* Arber, 1917, p. 27, pl. iii, fig. 8. † Walkom, 1925*a*, p. 72, pl. ix, fig. 2.

Fig. 3, B, 395u, represents another individual from the Molteno Beds at the Waterfall, Upper Umkomaas Valley, Natal, belonging probably to this species, but by reason of its rather large polygonal meshes recalling *C. zeilleri*, Seward ; its outer margin is unfortunately unknown.



Text-fig. 3.—A, B, *Chiropteris cuneata* (Carr.) ; C, D, E, *Chiropteris copiapensis*, Solms.

Chiropteris copiapensis, Solms-Laubach.

Text-fig. 3, C, D, E.

1898. *Sagenopteris* (*Cyclopteris*) *cuneata*, Shirley, Geol. Surv. Queensland, Bull. No. 7, p. 24, pl. xxiii.

1899. *Chiropteris copiapensis*, Solms-Laubach, Neu. Jahrb., B. Bd. xii, 3, p. 593, pl. xiii, figs. 1, 2, 3.

This coriaceous cuneate frond, 8326, is about 6 cm. in length and narrow, expanding rapidly near its termination, the outer margin

being possibly either continuous or else digitate as in D, 8323, which is provisionally regarded as belonging to the same species. The close-set veins that radiate from the base divide repeatedly with cross-connections as shown in the enlargement E, but distally there is a tendency to simple bifurcation.

On this slab 8326 there are two practically identical pinnae set at an angle of 70 degrees, but with their bases 1·5 cm. apart and hence probably borne on the same stalk, a find which strengthens the view, drawn from the examination of the specimens of *C. cuneata* described above, that the leaves may have been disposed in a whorl, for it is significant that at the base of each of the two pinnae on this slab the tip of the narrow lamina shows signs of expansion and curvature.

The form is much narrower than *C. cuneata*, but agrees well except for a somewhat smaller size with *C. copiapensis* from the undoubted Rhaetic Beds of La Ternera in Chile. The South African Museum possesses a specimen, No. 7110, of this Chilian form from Cacheuta, Argentina, which is identical with the Molteno plant, and which also shows the slightly turned-down end of the petiole. The fragment from the Ipswich Series of Queensland figured by Shirley as *Sagenopteris* (*Cyclopteris*) *cuneata*, which is apparently without a mid-rib, can perhaps be referred to the Chilian form, though the venation is a little more open.

The specimens are from the Molteno Beds of the Upper Umkomaas Valley, Natal.

Chiropteris zeilleri, Seward.

1903. *Chiropteris zeilleri,* Seward, Ann. S.A. Mus., vol. iv, pt. 1, p. 63, fig. 7.

No additional examples have been discovered and there is nothing to add to the description of this fossil, the original of which from Cyfergat is preserved in the British Museum.

FILICALES—HYDROPTERIDAE.

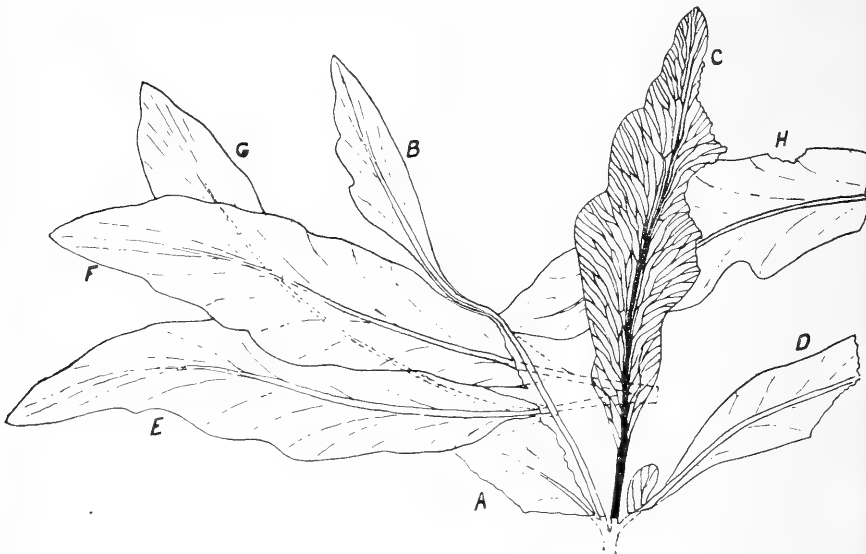
Genus SAGENOPTERIS, Presl.

Sagenopteris longicaulis, sp. nov.

Text-fig. 4.

The slab of black shale, 8670, figured carries impressions of eight leaflets seemingly belonging to two verticils. The leaflets, the

largest of which attains a length of 7 cm. and a breadth of 1·5 cm., are lanceolate, with acute apex, crenulate margins—which are almost lobiform in places—and narrow gradually towards the base, where there is an obvious asymmetry of the pinna. Curious is the small lobe at the base of D. The mid-rib is prominent in the lower half of the leaflet, but towards the apex it breaks up into sub-parallel or gradually diverging veins with occasional cross-connections. The secondary veins, which are also coarse, are given off very acutely



TEXT-FIG. 4.—*Sagenopteris longicaulis*, sp. nov. The venation is only figured in one of the leaflets; the fine lines in the others are diagrammatic.

from the mid-rib and run at first nearly parallel to the latter, curving gradually away and forking repeatedly with anastomosis, thus producing a network very like that of *Glossopteris* and fairly open in places; there seems to be a very slight thickening along the crenulate margin of the lamina. These several important characters definitely establish this form as *Sagenopteris* and not *Glossopteris*.

Interest centres in the method of attachment of the pinnae to the petiole, because in practically all the species of *Sagenopteris* described, the leaflets appear to have been verticillate and sessile, but in *S. undulata*, Nath., from the Rhaetic of Scania, which resembles this specimen closely, Halle * has found that the bundle of the petiole may

* Halle, 1910, p. 5.

sometimes fork into two branches, each dividing into two strands, which form the mid-ribs of the pinnae ; his figures (pl. XVI, figs. 2 and 3) bring out this uncommon character. On the counterpart, 390u, of that figured here, two of the leaflets corresponding to E and F are found to have their mid-ribs prolonged into what may be considered as petiolules, each about 1 cm. long, before uniting, as shown by the broken lines ; unfortunately the rest below this junction is missing and reconstruction thereof must be speculative. There can be no doubt, however, that the four leaflets A, B, C, and D, which converge towards the lower part of the figure, were grouped into a verticil, as shown by the dotted lines in the drawing, for the proximal portion of each leaflet is narrower on the side included in the angle between each pair of petiolules, an important feature in the descriptions of several species of *Sagenopteris* fronds. The exceptional length of the support in B is doubtless due to the youthful state of the leaflet in question. The pinnae E, F, G, and H obviously composed a second verticil, H having been considerably displaced during the entombment of the plant.

On the counterpart of H a boat-shaped body 2·5 mm. in length was found in contact with the margin of the lamina and is comparable with the supposed sporocarps described by Nathorst in association with *Sagenopteris* leaflets. Only the interior surface is exposed, showing longitudinal grooves and ridges converging upon the pointed extremity.

The group of stalked fronds radiating from a stem-like structure, described by Feistmantel * as *S. polyphylla*, resemble in their mode of attachment the above, but that form, as indeed remarked by Arber,† is certainly *Glossopteris retifera*. Of the few species of *Sagenopteris* that bear any resemblance to the Molteno fossil, the only one which is known to have a comparable attachment is *S. undulata*, Nath.,‡ from the Rhaetic of Scania, with, however, smaller pinnae showing wavy margins and having somewhat finer meshes. Our specimen is practically identical with the incomplete leaves described by Thomas § as *S. kamenkensis* from the Jurassic (Bathonian) of Southern Russia, which possesses the same lobate margins and open network, and the South African form could well be referred to that species were it not that the mode of attachment of the pinnae in the Russian form is unknown.

* Feistmantel, 1881, pl. xli, A. † Arber, 1905, p. 83.

‡ Halle, 1910, in which references are given.

§ Thomas, 1911, p. 59, pl. i, figs. 10, 11.

Under the circumstances it has been considered preferable to confer a distinct specific name on this specimen which comes from the Molteno Beds of the Upper Umkomaas Valley, Natal. Attention might further be drawn to the small example of this genus from the Beaufort Beds, dealt with on p. 399.

FILICALES—THINNFELDIAE.

Genus THINNFELDIA, Ettingshausen.

The history of this genus prior to 1903 is set forth in the useful summary by Seward * who, however, has taken up too conservative an attitude as regards the individuality of the several "species" created upon material from the Gondwana System. In 1912 Gothan † revised the genus and, upon the bases of form, the structure of the epidermis and the geographical distribution of the various species, was led to separate off from *Thinnfeldia* a new genus *Dicröidium*, the main points of distinction being as follows :—

In *Thinnfeldia* the frond is simple, generally pinnate, veining alethopterid seldom with inclination to odontopterid, epidermis thick with straight cell-walls, stomata with guard-cells regularly arranged. The genus is confined to the Rhaetic and Lower Jurassic of the Northern Hemisphere.

In *Dicröidium* the frond is always once forked, each branch generally pinnate, seldom bipinnate, veining odontopterid seldom alethopterid, epidermis delicate, cell-walls wavy, stomata irregularly arranged without guard-cells. The genus is restricted to those regions having the Glossopteris Flora, *i.e.* the Southern Hemisphere, where it is abundant. According to this scheme of classification the South African forms would have to be grouped under *Dicröidium*.

In 1914 Antevs ‡ discussed in more detail the genus in question and also the allied forms, his paper being the most important that had appeared on the subject, and especially valuable because of his critical examination of Gothan's generic distinctions, although in the end he is induced to accept such a proposed twofold subdivision.

In 1917 Walkom § reviewed the position in the light of information forthcoming from Australia and reached the important conclusion that the critical distinctions set up by Gothan were of far less im-

* Seward, 1903, p. 50.
† Gothan, 1912.
‡ Antevs, 1914.
§ Walkom, 1917, p. 12.

portance than the latter had averred and that the separation of this new genus *Dicröidium* was unwarranted, a view reached independently at about the same time by Arber * in describing material from New Zealand, and accepted by palaeobotanists generally.

Gothan first of all laid stress upon the dichotomous character of the fronds ascribed to *Dicröidium*, but Antevs pointed out that such a habit is pretty general among those forms that are, without doubt, closely allied to *Thinnfeldia*, such as in *Pachypteris* for example. Secondly, although Gothan regarded *Thinnfeldia* as including only simply pinnate forms, *T. obtusiloba* (Sap.), which Antevs accepts as correctly placed in that genus, is bipinnate. Gothan recognised that fact, and, in a postscript, included in *Thinnfeldia* as well species having bipinnate fronds.

Thirdly, as regards the structure of the epidermis, the differences are not as distinct as Gothan has tried to make out, since he overlooked Seward's † examination of the cuticle in *T.* (*Dicröidium*) *odontopteroides*, in which the cell-walls are not sinuous, to which must now be added the observations by Walkom ‡ on the cuticle in *T.* (*Dicröidium*) *lancifolia* of a corroborative nature, while on the other hand, Antevs § has found curved cell-walls in *T. rotundata* and *T. nordenskioldi*, with arrangement almost indistinguishable from the structures in *T.* (*D.*) *feistmanteli*. Similar epidermal structures, it can therefore be remarked, are to be found in both *Thinnfeldia* and *Dichroidium*.

Fourthly, Antevs has stressed the unreliability of a distinction based upon geographical distribution, several species of *Thinnfeldia* (in Gothan's sense) having been described from the Southern Hemisphere, such as *T. m'cCoyi*, Sew., from the Jurassic of Victoria, *T. pinnata*, Walk., from the Jurassic of New South Wales, which incidentally is pinnate, and the one referred in this paper to *T. rhomboidalis*, omitting for the moment several forms such as *T. aquilina* from Queensland, and *T. constricta* from Grahamland, regarding which there might be differences of opinion.

Fifthly, the pinnule form and venation can next be considered, bearing in mind that insufficient regard has often been paid to the great variation in those characters in different parts of the same frond. There is a marked alteration in outline in *T.* (*D.*) *lancifolia* from odontopterid lobes in the young leaves, or in those showing arrested growth (as in the angle of the forking), to elongated pinnules

* Arber, 1917, p. 48.
† Seward, 1903, pl. ix, figs. 7, 8.
‡ Walkom, 1917, text-fig. 6.
§ Antevs, 1914, pl. i, figs. 3–6.

in which the length may exceed four times the breadth. This species, as Antevs has noted, bridges the gap between *T.* (*D.*) *odontopteroides* on the one hand, and *T. rotundata* on the other. Similarly, in *T.* (*D.*) *feistmanteli* the small, simple basal pinnules on the main rachis are devoid of a mid-rib, whereas the larger ones are compound, and have quite a strong mid-rib.

To sum up, it can be stated that the characters used by Gothan for separation are not sufficiently distinctive, not one of them being constant for either "genus"; moreover, since his paper appeared, several new species have been described from the Southern Hemisphere, which add considerably to our knowledge, and there can be little doubt as to the wide and polymorphic nature of the genus *Thinnfeldia*. The relationship to the very closely allied genus *Pachypteris* will be dealt with under the account of the latter.

As regards the affinities of *Thinnfeldia*, Antevs,* reviewing the evidence and including work of his own, reached the conclusion that it was not a filicinean genus, but belonged to a group of extinct plants that stood between the ferns and the gymnosperms. Since that date Walkom † has described fertile fronds of both *T. feistmanteli* and *T. lancifolia*, showing the form of the sori, which are from 3 to 5 in number, and the sporangia (while one of *T. lancifolia* has now been found in this collection), these indicating affinities with both the Gleicheniaceae and Marattiaceae, and suggesting a fairly primitive type of fern. He has accordingly instituted a new family, the *Thinnfeldiae*, to contain them. Subsequently he pointed out ‡ the resemblances with the genus *Danaeopsis*, which belongs to the Marattiaceae.

Before proceeding to the description of the various species in the collection, it will be useful to make some remarks upon the status of the species *T. sphenopteroides*, Sew.§ This was established from two examples, but a careful examination of the types has forced me to conclude that the grounds therefor are unsatisfactory.

The specimen, 318f, figured in Seward's pl. v, fig. 2—which, incidentally, came from Cala, and not from Konings Kroon—can without hesitation be referred to *T. lancifolia* (Morr.); the supposed lobing of the pinnules is deceptive, such an apparent character being due primarily to a slight crinkling of the lamina caused by the presence of the secondary veins, and secondarily to the overlapping of the matrix at the margins over the hollows thus formed. By the removal

* Antevs, 1914. † Walkom, 1917, p. 12. ‡ Walkom, 1925*b*, p. 218.
§ Seward, 1908, p. 94, pl. iv, fig. 2; pl. v, fig. 2.

of the sandstone concealing the edges of the lamina the margins of the pinnules were found to be entire.

His second specimen (182f, pl. iv, fig. 2), from Konings Kroon, Elliot, is decidedly a *Callipteridium*, with which the shape of the frond agrees. With the exception of the lowest left-hand pinna, all the pinnae bear confluent lanciform pinnules with even margins, serrated in the basal part of the lower right-hand pinna, while one or two similar, or more odontopterid, pinnules are borne on the rachis between adjacent pinnae. These characters, taken with the venation, are sufficient to place the form under *C. stormbergense*, Sew. The lower left-hand pinna is abnormally developed in that it is actually and entirely bipinnate; indeed, there are two places where single pinnules are attached directly to the pinna rachis, just as in the main frond. More or less similar instances of such architectural variation are known among the ferns, for example in the living *Pteris*.

Under these circumstances the species *T. sphenopteroides* has to be deleted from our list.

Thinnfeldia odontopteroides (Morris).

(For synonymy see Antevs, 1914, p. 55, and Walkom, 1917, p. 19.)

Frond pinnate, rachis forked, pinnules below as well as above the point of bifurcation, close, alternate, or sub-opposite, oval or rhombic, with a short and blunt or rounded apex, and cohering at the base. Venation odontopterid, veins numerous, emerging directly from the rachis, repeatedly forked, slightly diverging. Texture of lamina not very thick.

This most common and abundant species is readily distinguished from *T. lancifolia* by the stumpy pinnules, only rarely constricted at their base, and the absence of any well-defined mid-rib, while not uncommonly they are so crowded that adjacent pinnules overlap slightly. The figured South African examples belonging to this species embrace the following: Feistmantel, 1889, pl. i; pl. ii, figs. 1, 1*a*, 3, 3*a*; pl. iii, figs. 5, 8, 8*a*; and Seward, 1903, pl. vii, fig. 1; pl. viii, fig. 7, 8; pl. xi, fig. 2; text-fig. 6.

This species is widely distributed in the Southern Hemisphere, in India, Queensland, New South Wales, Tasmania, New Zealand, Argentina, and Chile, but has not been yet recorded in Indo-China.

Thinnfeldia lancifolia (Morris).

Text-figure 5, A, B.

(For synonymy see Antevs, 1914, p. 58, and Walkom, 1917, p. 21.)

This species is common in the Molteno Beds, and is rather sharply defined from both *T. odontopteroides* and *T. feistmanteli.*

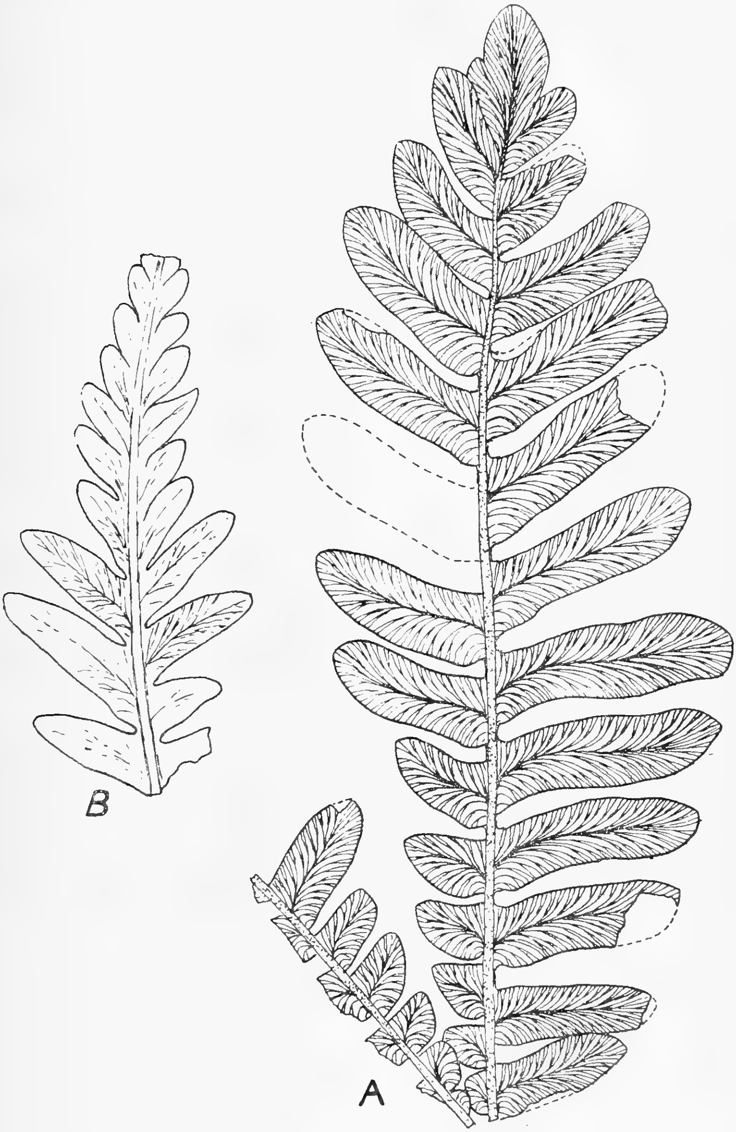
Frond forking into two pinnae set at an acute angle, rachis stout and pitted, pinnules varying in shape according to their position on the rachis, close, alternating or sub-opposite, generally broad and lanciform, sometimes curved, blunt, attached by the whole of the base, occasionally somewhat decurrent. Venation alethopterid, mid-rib not very conspicuous, vanishing towards the apex, secondary veins forked, more rarely simple, those at the very base springing directly from the rachis. The pinnules within the fork are small and typically odontopterid, both in outline and venation, becoming elongated and showing a more defined mid-rib in those situated higher up the pinnae. Outside the forking the pinnules are elongated, but towards the base of the frond they decrease in size in a proximal direction, a feature more marked still in *T. feistmanteli.* The normal type of pinnule is generally maintained with gradual decrease in size, but increase in obliquity almost to the apex of the frond, the latter terminating in a conspicuous compound lobe.

The forms figured by Seward (1903, pl. vii, figs. 8, 8*a*) and (1908, pl. iv, fig. 1) represent this species, while a good example, 8649, from the town of Maclear, text-figure 5, A, shows the main characters and displays the striking asymmetry of each pinna above the forking. In 296f from a spot 2 miles west of Cala, text-figure 5, B, the *lancifolia* habit of the pinnules in the mid-portion of the pinna gives way to a typical odontopterid character in the apical ones, a feature upon which stress has been laid by Antevs.

An important point is the decurrent nature in certain examples, while at the same time the mid-rib emerges from the rachis at a more acute angle, so that the pinnules may become linked together at the base, the rachis being slightly winged. Specimen 448q from Maclear shows this character, and is similar to Szajnocha's * figure of *T. lancifolia* and Antevs' † illustration of this species. Another variation is a slightly decurrent character with the upper edge of the base separated from the rachis by a distinct sinus. A good example is the specimen

* Szajnocha, 1888, pl. i, fig. 5.

† Antevs, 1914, pl. v, fig. 6.



TEXT-FIG. 5.—A, B, *Thinnfeldia lancifolia* (Morr.).

referred by Seward * to *T. rhomboidalis*, but which has very little in common with Ettingshausen's type. These minor variations

* Seward, 1903, pl. viii, fig. 1.

become of some importance when the affinities of this species to *T. major* (Racib.) are being considered, the pinnules of which are very similar in form and venation, but closer set, while the frond is simply pinnate instead of forked.

T. lancifolia ranges from the uppermost strata of the Beaufort Series to horizons more than half-way up in the Molteno Beds. It is confined to the Southern Hemisphere, having been recorded from the Ipswich Beds of Queensland, Hawkesbury Series of New South Wales, Mesozoic of Tasmania and New Zealand, and Trias-Rhaetic of Argentina and Chile.

THINNFELDIA ACUTA, Walkom.

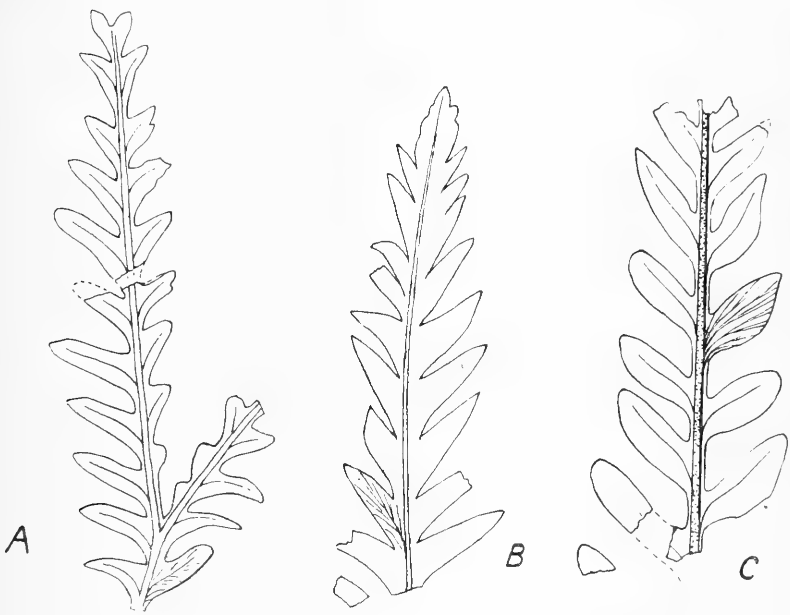
Text-figure 6, A. B.

1898. *Thinnfeldia indica*, var. *falcata*, Shirley, Queensld. Geol. Surv., Bull. vii, p. 21, pl. vii, fig. 2.
1914. *Thinnfeldia aquilina*, Antevs, Kung. Svensk. Vetens. Akad. Hand., Bd. 51, No. 6, p. 42.
1917. *Thinnfeldia acuta*, Walkom, Queensld. Geol. Surv., Publ. No. 257, p. 23, pl. iii, fig. 4.

In 1898 Shirley described three forms from the Ipswich Beds under the names of *T. indica*, varieties *aquilina*, *media*, and *falcata* respectively, which Antevs in his revision provisionally grouped together under the specific name of *T. aquilina*. Walkom, re-examining the types, came to the conclusion that the first two of these were merely examples of *T. lancifolia*, but placed the third in a new species, with which might perhaps have to be put the form described as *Gleichenia lineata*.

The specimens 8650–2 from Wen Fontein, Queenstown district, text-figure 6, A, differ considerably from *T. lancifolia*, and, except for its smaller size, agree with Shirley's figure of his variety *falcata*, now called *T. acuta*. Owing to the impressions being on a fine-grained sandstone, full details of the venation can rarely be made out, but it is alethopterid, with the primary veins becoming faint toward the apices of the openly set, sub-opposite pinnules. The upper edge of each pinnule is convex, the lower one concave, the base strongly decurrent, and joined to the one below by a narrow wing. Those situated within the forking of the slender rachis are modified, while the pinnules towards the apex of the pinna are almost triangular in outline. The lamina has a leathery texture.

A second example 8647, from Vaal Krantz, Queenstown, text-figure 6, B, is more like Walkom's species, while a third example, K. 1, 299, which is very similar, comes from the shales on Duart Castle, Hlatimbe Valley, Natal. A fourth specimen, 5905, from Konings Kroon, Elliot, has pointed pinnules up to 3 cm. in length and 1 cm. in width, with the mid-vein persistent up to the apex, this



TEXT-FIG. 6.—A, B, *Thinnfeldia acuta*, Walk.; C, *Thinnfeldia rhomboidalis*, Ett.

and the triangular shape serving to distinguish the frond from *T. lancifolia*.

This form was some years ago identified by me * with *T. indica* var. *falcata* and, hence following Antevs, with *T. aquilina*, but, with the breaking up of the latter species by Walkom, comparison must now be made with his *T. acuta*, which, as remarked, is somewhat larger, and moreover lacks an apex to the dichotomous frond. It also agrees well with the description by Tennison-Woods of *Gleichenia lineata* from the Ipswich Beds, excepting that the pinnules in the latter are slightly contracted at their base, which is not the case in the Molteno plant.

* Du Toit, 1926, p. 275.

THINNFELDIA FEISTMANTELI, Johnston.

1908. *Thinnfeldia odontopteroides*, Seward, Quart. Journ. Geol. Soc., vol. lxiv, p. 90, pl. v, fig. 1, text-figs. 3, 4.

1912. *Dicroidium feistmanteli*, Gothan, Abh. Nat. Gesell. Nürnberg, vol. xix, pt. iii, p. 78, pl. 16, fig. 1.

1914. *Dicroidium feistmanteli*, Antevs, Kung. Svensk. Vetens. Akad. Hand., Bd. 51, p. 52, pl. i, figs. 5, 6; pl. v, fig. 1.

1917. *Thinnfeldia feistmanteli*, Walkom, Queensl. Geol. Surv., Publ. No. 257, p. 17, pl. i, fig. 3; pl. ii, figs. 1, 2; text-fig 5.

(For full synonymy see Walkom, 1917, p. 17.)

Frond large, bipinnate, rachis very stout, forked. Pinnae below as well as above the bifurcation, close, alternate, long, almost linear, gradually becoming narrower. Pinnules close, varying in shape, rhombic, oval or crescentic, with a short and blunt or rounded apex, more or less coherent at the base, sometimes fused. Inter-pinnate pinnules may be present. Venation odontopterid, composed of a greater or lesser number of veins, frequently dichotomising, slightly diverging from a common point in the base of the pinnule or derived from the whole base thereof. Texture of the lamina thick.

Feistmantel * has given figures of some specially fine fronds from the Hawkesbury Series of New South Wales; Seward shows a similar form from the Molteno Beds, while Walkom has given illustrations of Queensland examples, so that there is no need for any further drawings. All these cases are characterised by the extremely stout rachis, by the broad odontopterid pinnules set closely together, and by the presence of similar pinnules on the main rachis both between the pinnae and on its proximal portion. Isolated portions of pinnae could very readily be taken as belonging to *T. odontopteroides*, as was done in the past.

Considerable interest centres about the form described by Seward † from Vaalbank, Aliwal North district, which Antevs regards as a young specimen of *T. feistmanteli*. The older segments are pinnatifid and in one case (94g) pinnatisect with pinnules on the main rachis between the pinnae, but in the majority the margin is merely denticulate or gently lobed, while the extremity is rounded or nearly pointed. At the apex of the frond the segments are simple pinnules with marked mid-rib and pointed tip (Seward, text-fig. 3C), very much like those

* Feistmantel, 1890, pls. xxiii–xxv.

† Seward, 1908, text-figs. 3A, 4.

in *T. lancifolia.* Closer inspection shows that at the base of the pinna the upper margin is practically free, a character that is not so well developed in the older segments, but even in the latter the base is considerably contracted, a feature wanting in *T. lancifolia.*

Such pinnatifid pinnae are of much larger size in two specimens 3n and 11n from Konings Kroon, Elliot, attaining a length of 8 cm. and a breadth of 2 cm., otherwise corresponding well with Seward's text-fig. 4 from Witkop near Jamestown. From this type it is but a step to the lobate pinna of the example regarded as the variety *trilobita* of this species and detailed below.

Thinnfeldia feistmanteli is known from the Ipswich Beds of Queensland, Hawkesbury Series of New South Wales, Leigh Creek Beds of South Australia, Mesozoic Beds of Derby, West Australia,* and of Tasmania, and Argentina. Antevs † has pointed out the resemblances to *Dichopteris visianica,* Zigno, and to certain species of *Odontopteris,* while the form described by Sellards ‡ from the Uppermost Permian of Kansas as *Glenopteris* (*?*) *lobata* is probably very closely allied.

Thinnfeldia feistmanteli, var. trilobita, Johnston.

1885. *Thinnfeldia trilobita,* Johnston, Pap. Proc. Roy. Soc. Tasmania, p. 372.
1888. *Thinnfeldia trilobita,* Johnston, Geol. Tasmania, pl. 24, fig. 6; pl. 26, fig. 12.
1889. *Thinnfeldia trilobita* (?), Feistmantel, Abh. k. böhm. Gesell. Wiss. Prag., p. 65, pl. ii, figs. 2, 2*a*, 2*b*.
1890. *Thinnfeldia trilobita,* Feistmantel, Geol. Surv. N.S.W., Pal., Mem. 3, p. 106.
1914. *Dicroidium trilobitum,* Antevs, Kung. Svensk. Vetens. Akad. Hand., Bd. 51, p. 60, pl. viii, fig. 12.

The fragments from Indwe figured by Feistmantel and compared by him with Johnston's *T. trilobita* from Tasmania would seem from the parallel position of the two pinnatifid pinnae to belong to a bipinnate type of frond such as *T. feistmanteli* and therefore to be distinct from the dichotomous Tasmanian form which Walkom has allotted to his new genus *Johnstonia,* as *J. trilobita.*§ No further examples have been obtained and we have therefore only Feistmantel's account of this form to refer to, which shows that the pinnules are

* Antevs, 1913. † Antevs, 1914, p. 60.
‡ Sellards, 1900, p. 187, pl. xxxvii, fig. 4; pl. xlii, fig. 2.
§ Walkom, 1925, p. 81, fig. 10.

decurrent and confluent at the base, each terminating in three lobes of which the two outer ones are less prominent than the medial.

The venation is like that in *T. feistmanteli,* in which a similar slight lobing is occasionally to be found in the apical parts of the pinnae, as indicated in certain of Feistmantel's figures of Australian fronds (1890, pl. xxiv, figs. 1*a*, 1*b*, 1*c*, 2). Both Feistmantel and Antevs pointed out the resemblance to some forms of *T. odontopteroides*—in which *T. feistmanteli* was formerly included—but the latter signified his readiness to accept the full specific designation of *T. trilobita.*

In view of the existence of somewhat lobate margins and of pinnatifid characters in the pinnae of certain examples of *T. feistmanteli,* as mentioned above, it may well be that the form under review would have to be placed under the latter. There would furthermore seem to be rather more doubt as to its claim to distinct specific rank, and under these circumstances it is deemed more satisfactory to consider it merely as a variety of *T. feistmanteli* in the absence of better material.

Thinnfeldia narrabeenensis, Dun (MS.).

Plate XVIII, fig. 3.

1925. *Thinnfeldia narrabeenensis,* Walkom, Proc. Linn. Soc. N.S.W., vol. i, pt. 3, p. 218, pl. xxvi, fig. 4; pl. xxvii, figs. 3, 6; pl. xxviii, figs. 1–4.

This rather fine example, 8321, from the Molteno Beds of Duart Castle, Hlatimbe Valley, Natal, is all but identical with the form described under the above name from the Lower Triassic Narrabeen Beds of New South Wales and displays several points of unusual interest. The portion of the frond preserved shows a very stout pitted rachis bearing linear pinnules with even margins that are quite short and set at right angles to the rachis in the proximal portion, becoming more oblique, exceeding 10 cm. in length and reaching nearly 2 cm. in breadth in the mid-frond, and terminating at the apex in pointed pinnules that are partly confluent at their base. The mid-vein in each is percurrent at the base, is stout and generally pitted. The pinnules are slightly contracted at their base and not decurrent, while the lamina is coarse and thick. The secondary veins can only be made out in certain parts with difficulty, but are close, diverge from the mid-vein at an angle of thirty degrees, curve away therefrom and bifurcate more than once before reaching the margin, much as in *Thinnfeldia lancifolia.* Near the apex, and

particularly in the terminal pinnules, the divergence from the mid-vein of the secondary veins is less and some emerge from the rachis as well.

The plant agrees very closely with the form figured by Walkom as *T. narrabeenensis* (see especially his pl. xxvi, fig. 4, and pl. xxviii, fig. 4). As he has pointed out, though, the Australian examples, while displaying the general *Thinnfeldia* characters, show at the same time strong resemblances with *Danaeopsis hughesi*, remarks which also apply to the Natal fossil, so that the question is raised as to whether this species ought not perhaps to be included under *Danaeopsis hughesi* or the genus *Thinnfeldia* extended so as to embrace the latter species.

The Molteno plant, while quite distinct from *T. lancifolia*, certainly possesses marked *Thinnfeldia* characters, and, although its size is an unusual feature, Kurtz * has figured fronds of undoubted *T. lancifolia* from Argentina having pinnules up to 5 cm. in length. It should be pointed out that *Danaeopsis hughesi* possesses three marked characters that are absent from the form under description: first, a decurrent and usually confluent base to the pinnules; secondly, as emphasised by Feistmantel,† an asymmetrical position to the mid-vein, which is always closer to the upper edge of the pinnule—a feature present not only in the Indian examples of this genus, but in those from South Africa; and, thirdly, a single bifurcation of the secondary veins on leaving the mid-vein, whereas in our specimen they tend to fork a second time. On these grounds the present form is regarded as belonging to *Thinnfeldia* and not to *Danaeopsis*.

Attention should be directed to its similarity to certain of the forms described by Sellards ‡ from the uppermost Permian of Kansas under the generic name of *Glenopteris*, particularly to *G. splendens*, in which the large spathulate pinnules have an auricled base, a per-current mid-vein and secondary veins that only fork on approaching the margin. As Seward § has remarked, this genus differs in no essentials from *Thinnfeldia*, the resemblance being furthered by the discoveries of these new species of *Thinnfeldia*—*T. narrabeenensis*—from horizons lower down in the Triassic.

* Kurtz, 1921–22, pl. xviii, p. 174; pl. xix; pl. xx, pp. 297, 311.

† Feistmantel, 1882, p. 26, pls. iv–x.

‡ Sellards, 1900, p. 182, pl. xxxvii, figs. 1, 2; pl xxxviii, fig. 1; pl. xl.

§ Seward, 1910, vol. ii, p. 538.

THINNFELDIA RHOMBOIDALIS, Ettingshausen.

Text-figure 6, C.

1852. *Thinnfeldia rhomboidalis*, Ettingshausen, Abh. K. K. Reich. Wien., Bd. i, Abt. 3, p. 2, pl. i, figs. 4–7.

1867. *Thinnfeldia rhomboidalis*, Schenck, Foss. Flor. Grenzsch., p. 116, pl. xxvii, figs. 1–5, 7, 8.

1914. *Thinnfeldia rhomboidalis*, Gothan, Abh. Naturh. Gess. Nürnberg, vol. xix, p. 30, pl. xx, figs. 2, 3 ; p. 122, figs. 1, 2.

1914. *Thinnfeldia rhomboidalis*, Antevs, Kung. Svensk. Vetens. Akad. Hand., Bd. 51, p. 27, pl. ii, fig. 5 ; pl. iv, fig. 4 ; pl. iv, fig. 5.

(For full synonymy see Antevs.)

Under this name Seward described in 1903 the fragment which is referred to under *T. lancifolia*, since it really belongs to that species. Gothan having argued very strongly that the forms from the Southern Hemisphere belong to the genus *Dicroidium* and not to *Thinnfeldia*, the discovery in South Africa of this typical European species is of no small importance.

The specimen, 8317, from Duart Castle, Hlatimbe Valley, Natal, is part of a single pinna with a well-defined, pitted rachis bearing widely spaced, alternate pinnules that are oblique thereto, distinctly variable in their outlines, ranging from blunt to lanceolate, but all characterised by a slightly contracted base and decurrent lower margin, which is united to the upper edge of the pinnule below by a narrow wing along the rachis. The principal vein emerges quite acutely from the latter, but then bends and runs nearer to the upper than the lower edge of the pinnule, becoming broken up towards the apex, while the repeatedly bifurcating secondary veins are given off directly from the rachis as well as from the medial vein.

This is in full agreement with the several descriptions and figures of *T. rhomboidalis* ; attention can more particularly be directed to Ettingshausen (pl. i, fig. 5, reproduced by Antevs), Schenck (pl. xxvii, fig. 3) and Gothan (pl. 20, figs. 2, 3 ; pl. 21, fig. 3), which all practically duplicate the Natal specimen.

This species, which now makes an appearance to the south of the Equator, is known from the Rhaetic of Bayreuth, Steierdorf, and Nürnberg, and from the Jurassic of France, Germany, and Italy also, though these examples from post-Rhaetic rocks are, as Antevs has pointed out, by no means typical, even after excluding from them certain forms which probably do not even belong to *Thinnfeldia*.

C.—FERN-LIKE PLANTS AND PLANTS OF UNCERTAIN POSITION.

Genus PACHYPTERIS, Brongniart.

This genus, as instituted by Brongniart in 1828, was characterised by the absence of veins or only a single primary vein in the pinnules, but later the studies by Andrae, Nathorst, and Halle * have shown that *Pachypteris* is in its venation as well as in other characters very like *Thinnfeldia*; indeed Andrae in 1853 included the species called *T. rhomboidalis* in that particular genus.

Antevs † has pointed out that *P. lanceolata* is closely related to *Thinnfeldia* on the one hand and to *Scleropteris pomelii*, Sap., on the other. Seward ‡ again has included this genus in *Dichopteris*. Halle, in order to keep *Scleropteris* distinct from *Thinnfeldia*, has to uphold the generic status of *Pachypteris*. The latter is characterised by a generally stouter rachis bearing oblique, linear, opposite pinnules of rather thicker consistence. The venation is commonly much less distinct than in *Thinnfeldia* and frequently hardly discernible, but in the South African forms the venation is generally good. Saporta § particularly noted the *Thinnfeldia*-like mode of venation, and indeed used it to establish this form under that genus. The crucial difference to my mind is *the absence of any veins in the lower part of the pinnule arising directly from the rachis*, the secondary nerves being given off from the primary vein and bifurcating towards the margin. This would appear to constitute the only reasonable and practical basis of distinction between the two genera.

Some difficulty arises since Saporta appears to have included under *T. incisa* plants that are probably distinct, and, while Gothan || has retained Saporta's nomenclature, Antevs has on the other hand removed all those forms to *P. incisa*. It would be of some advantage to convert such of them having undoubted *Pachypteris* characters into *P. incisa*, leaving the remainder to be regarded either as *Thinnfeldia incisa* or as new species of *Thinnfeldia*, a course which will be followed here. As thus defined, the pinnate fronds from Grahamland named by Halle ¶ *Thinnfeldia constricta* would have to be regarded as *Pachypteris constricta*.

Seward has grouped *Pachypteris* with *Dichopteris*, but the venation

* Halle, 1913, p. 39.
† Antevs, 1914, p. 11.
‡ Seward, 1910, p. 550.
§ Saporta, 1873, p. 348.
|| Gothan, 1912, p. 69.
¶ Halle, 1913, fig. 10.

of the latter is so considerably different that, if the former has to be included in any other genus, it should be placed in *Thinnfeldia*, with which its alliances are greatest. Though not included here in the Filicales, it is probable that *Pachypteris* will before long have to be placed in the Family Thinnfeldiae instituted by Walkom.

Pachypteris acuta, sp. nov.

Plate XIX, fig. 2 ; text-figure 7, A, B, C.

The fronds A and B, 8331, from the town of Maclear, are bipinnate, probably with stout forked rachis and oblique, lanceolate, oppositely-set pinnules contracted towards their base, decurrent and with marked costae. In the fork the pinnules are much smaller, the costa of the first one being greatly extended ; towards the distal part of the frond the pinnules may be more obliquely set, and are generally longer and narrower.

The venation is usually indistinct, though a primary vein can always be made out that is gently decurrent to the rachis. Figure C shows an example, 8327, from the same locality, in which the veining is unusually clear, and the difference from the arrangement in *Thinnfeldia* will be appreciated ; each secondary vein bifurcates once and runs straight to the margin. In A the venation, though not so sharp, is similar, the secondary veins not being quite so numerous.

The form greatly resembles *P. lanceolata*, Brong., from the Lower Jurassic of Europe, but the more acute shape of the pinnules, their closer setting, and wider angle render it preferable to place the form in a new species, *P. acuta*.

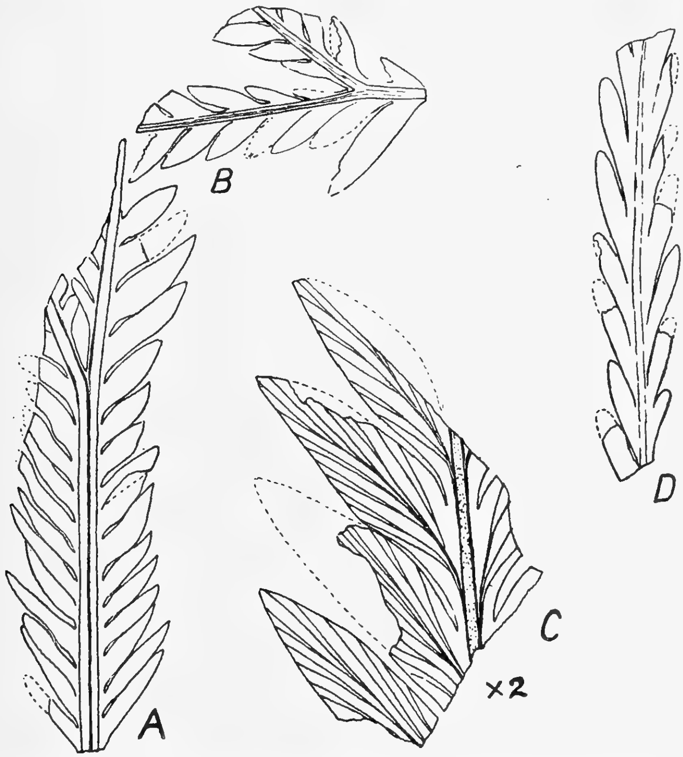
Another example of a dichotomous frond, 8319, Plate XIX, fig. 2, from Duart Castle, Hlatimbe Valley, Natal, has still more elongated and sharply pointed pinnules, and also exhibits an occasionally dentate margin, generally along the lower base of the pinnule, a character not infrequent in the genera *Pachypteris* and *Scleropteris*. This particular form greatly resembles one of Saporta's examples of *Thinnfeldia incisa* from the base of the Lias in France.*

Specimens 23s and its duplicate 24s are of importance as representing the only determinable plant remains from an horizon in the Union higher than the Molteno Beds, as they come from about one-third way up in the succeeding Red Beds at the boundary between Rietfontein and Leeuw Spruit, north-west of Dordrecht, from a band

* Saporta, 1873, pl. xli, fig. 4.

of greyish micaceous mudstone in the dominant red, purple, and green mudstones and yellow sandstones.

The dichotomous rachis bears alternating, linear, pointed pinnules set at a wide angle in the lower part of the frond, but more acutely



TEXT-FIG. 7.—A, B, *Pachypteris acuta*, sp. nov.; C, *Pachypteris acuta*, ×2; D, *Pachypteris lanceolata*, Brong.

towards the apex, decurrent, but only slightly constricted at their base, and bluntly pointed. The venation is not very clear, but appears to correspond closely with that of *Pachypteris*, while the general habit agrees with *P. acuta*. It nevertheless also possesses certain features that are to be found in *Thinnfeldia*, and is very much like Saporta's *T. incisa* (pl. xli, fig. 3).

PACHYPTERIS INCISA (Saporta), *pars*.

Text-figure 8, A, B, C.

1873. *Thinnfeldia incisa* Saporta, Paléont. Française, vol. i, p. 348, pl. xlii, figs. 1, 2, 2*a*.

1911. *Thinnfeldia incisa*, Zeiller, Bull. Soc. Géol. France, tom. xi, p. 323, pl. ii, figs. 1–3.

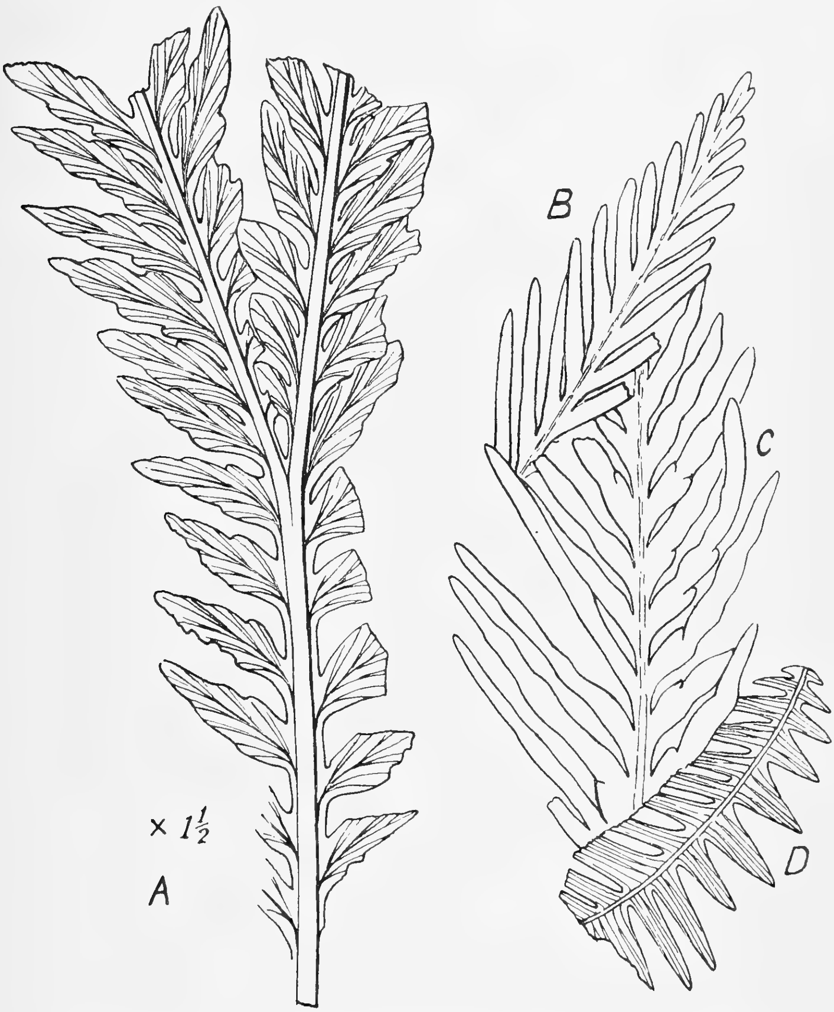
1912. *Thinnfeldia incisa*, Gothan, Abhandl. Naturh. Gesell. Nürnberg, vol. xix, p. 69, pl. 13, fig. 2.

1. The dichotomous frond from Konings Kroon, Elliot, 5903, together with its duplicate, 5943, shows, text-fig. 8, A, a stout, pitted, alate rachis bearing pinnules set obliquely thereto, which are much contracted at their base and decurrent, tapering to their apices, and having slight and alternating lobings. Those in the forking of the rachis are small and unlobed. The primary vein is decurrent, and gives off at an acute angle the secondary veins, which then fork, the resulting pair of nerves passing into one of the lobings. The first of the secondary veins in the lower part of the pinnules is given off, just where the primary emerges from the rachis, to make a downward curve and fork almost immediately, but no veins could definitely be made out issuing directly from the rachis. In this respect, therefore, the venation differs from those of nearly all other species of *Thinnfeldia*, and the form would consequently be put under *Pachypteris*.

The resemblance with certain of Saporta's figures of *Thinnfeldia incisa* is strong, though admittedly in his fig. 2*a* some veins do occasionally emerge directly from the rachis, but only in the larger basal pinnules, and apparently where the basal lobing is well developed. In others of his drawings the pinnules are smoother and the venation typical of *Pachypteris*. It will be convenient to refer to the Elliot plant as *Pachypteris incisa*, noting at the same time that certain of the other forms ascribed to this European species scarcely display outlines such as to warrant the employment of the specific designation *incisa*.

2. On the slab 5917, from the same locality, are two examples, fig. 8, B, C, of which C shows very elongated pinnules, each with the peculiar faint lobings that confer a characteristic wavy appearance, by reason of their alternating positions. In B the lower pinnules are also of this kind, but in this example the distal ones are even-sided and spatulate, terminating in a blunt ovate pinnule at the apex.

3. A third example, 8318, from Duart Castle, Hlatimbe Valley, Natal, is practically the duplicate of 1, with lobed pinnules set at



TEXT-FIG. 8.—A, B, C, *Pachypteris incisa* (Sap.), A, × 1½; D, *Pterophyllum* cf. *braunianum*, Göpp.

wide angles to the dichotomous, alate rachis, and with identical venation.

4. In the fourth specimen, 936Wy, from Zastron in the Orange Free State, the pinnules situated in the fork of the two pinnae are

decidedly rhomboidal and very constricted at the base, rather like those of *Thinnfeldia constricta*, Halle,* from the Jurassic of Grahamland, but the others are elongated and show lobing, somewhat more marked than in the fig. 8, A. The secondary nerves all arise from the primary vein.

In discussing the affinities of these forms, attention has to be drawn to the strong resemblance to the much-discussed plant described by Feistmantel † from the Wianamatta Beds of New South Wales as *Gleichenia dubia*, but unfortunately the faintness of the venation in the type specimen prevents close comparison, and the same is the case with the similar form from the Ipswich Beds of Brisbane recorded by Shirley.‡ Gothan § considered it to be a species of *Dicröidium* (*Thinnfeldia*), but Antevs ‖ has criticised that view, and has given satisfactory reasons for ascribing it to *Pachypteris*, and not improbably the Australian plants may be identical with Saporta's *Thinnfeldia incisa* or, as it will be called here, *Pachypteris incisa*. The *Thinnfeldia incisa* from the Rhaetic Beds of Chile is said by Solms-Laubach ¶ to have the same venation as Saporta's species, but he also remarks that the veins are very like those in *T. rhomboidalis*, which suggests a form somewhat different from *Pachypteris*; not improbably it is a true *Thinnfeldia*. Such lack of precision as regards the nomenclature of these types can only be expected, since the form known as *T. incisa*, more than any other, constitutes a link between *Thinnfeldia* and *Pachypteris*.

Pachypteris lanceolata, Brongniart.

Text-figure 7, D.

1828. *Pachypteris lanceolata*, Brongniart, Hist. Végét. foss., p. 167, pl. xiv, fig. 1.

1908. *Thinnfeldia*, sp. Seward, Quart. Journ. Geol. Soc., vol. lxiv, p. 95, pl. ii, fig. 2.

(For synonymy see Seward, The Jurassic Flora, 1900, vol. i, p. 171, fig. 27.)

In figuring the two fragments from Maudesley, Lady Grey, as *Thinnfeldia*, Seward noted that the pinnae could well belong to

* Halle, 1913, text-fig. 10.

† Feistmantel, 1890, pl. xxvi, fig. 3.

‡ Shirley, 1898, pl. xxiii.

§ Gothan, 1912, pl. xv, fig. 3.

‖ Antevs, 1914, pp. 13, 52.

¶ Solms-Laubach, 1899, p. 600, pl. xiv, figs. 3, 4.

Pachypteris, and the examples that have since been obtained elsewhere display so close resemblances with *P. lanceolata* of the Lower Jurassic, as to render it desirable to group these forms under that species, despite the uncertainties attending the identification of apical portions of pinnae.

In 116g from Vaal Hoek in Aliwal North, figured here D, and also in 128g, the venation is much like that in *Pachypteris acuta*, only fainter. Bifurcation is represented in 293f from half-way up the Cala Pass, while the texture of the lamina is thick. Walton has figured a pinnate frond from the Forest Sandstone (Stormberg) of Southern Rhodesia, which he compares with the Maudesley examples, and which I think may possibly belong to the species under description. With it can also be compared *Scleropteris phillipsi*, Sap.,* from the Jurassic of France. The very close resemblance with *P. stelzeriana*, Gein. † from Argentina should not be overlooked; indeed the two plants may be identical, but the Argentine species lacks the symmetry of the Molteno form. I have, however, collected from Barreal, Argentina, a specimen, No. 7132, now in the South African Museum, which is indistinguishable from the form under description.

Genus TAENIOPTERIS, Brongniart.

The leaves belonging to this genus obtained from the Molteno Beds are by no means of common occurrence and are invariably in the form of fragments, which renders their determination difficult, the more so in that the specific differences among the *Taeniopteridae* of the Rhaetic and the Jurassic Epochs are generally slight. No fertile examples have been found, nor have any of the pinnules been discovered still attached to the rachis, though such is the case with a frond of *T. m'cClellandi* Old. and Morr., from the Forest Sandstone of Southern Rhodesia (p. 410).

Taeniopteris carruthersi, Tenison-Woods.

Text-figure 9.

1872. *Taeniopteris daintreei*, Carruthers, Quart. Journ. Geol. Soc., vol. xxviii, p. 355, pl. xxvii, fig. 6.

1883. *Taeniopteris carruthersi*, Tenison-Woods, Proc. Linn. Soc. N.S.W., vol. viii, p. 117.

* Saporta, 1873, pl. xlv, figs. 1–3.

† Geinitz, 1876, pl. ii, figs. 7–9.

1889. *Taeniopteris carruthersi,* Feistmantel, Abh. böhm. Ges. Wiss. Prag., Bd. iii, Folge vii, p. 65, pl. ii, figs. 6–10.
1903. *Taeniopteris carruthersi,* Seward, Ann. S. Afr. Mus., vol. iv, pt. 1, p. 59, pl. viii, figs. 5, 6.
1908. *Taeniopteris carruthersi,* Seward, Quart. Journ. Geol. Soc., vol. lxv, p. 98, fig. 6.

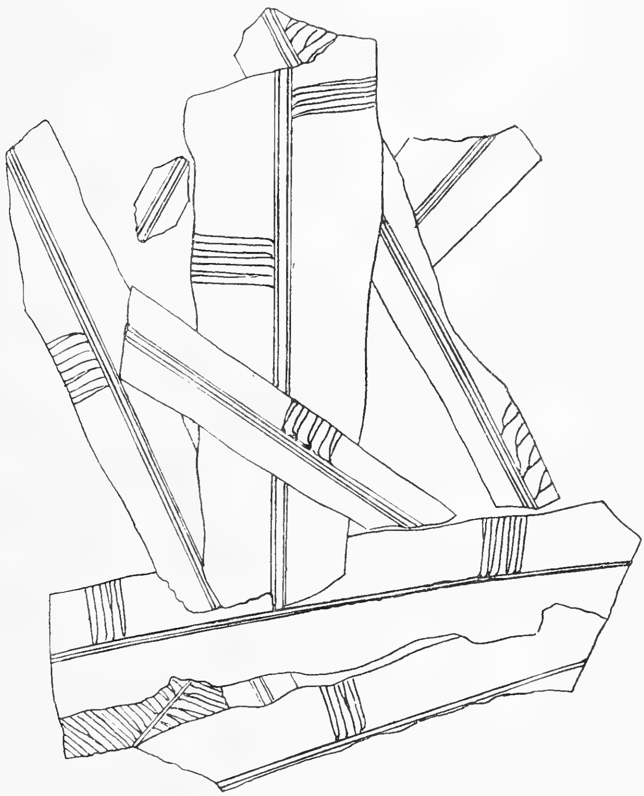
As Walkom * has remarked, this is not altogether a satisfactory species to deal with, since it is known only from fragments of the middle part of the leaf. In the collection from the fossiliferous band on Konings Kroon, Elliot, are examples fortunately showing the proximal and distal portions of leaves that must belong to this form, which show that they were strap-shaped with wavy margins, parallel-sided in the centre, acutely terminated, and contracting gradually towards the base into a stout petiole. There was considerable variation in width, examples ranging from 1 cm. up to 4 cm. being known, though some fragments 7 cm. broad probably belong to this form.

The mid-rib is very broad in the lower part of the leaf, up to 4 mm. wide, and strongly striated longitudinally, but rapidly becomes slender near the apex. As Carruthers states, the secondary veins leave it at an acute angle to pass out at right angles to the margin, but not uncommonly they emerge exactly at right angles; dichotomy takes place between the costa and margin. They number from 7 to 15 per cm., being farther apart in the lower part of the pinnule. In the apical portion they are given off more obliquely, and at the very termination the angle is quite acute.

Feistmantel has figured several examples from Indwe, while Seward has given three figures, one of which, fig. 4, as he himself doubted, is almost certainly a different species. His fig. 5 is a portion of a very narrow leaf with open venation, but he makes the suggestion that it might represent the lower and gradually tapering portion of a leaf belonging to this particular species. In this I believe that he is right, for a number of such leaves have been found of varying degrees of width, from just under 1 cm. upwards, all showing the characters of the broader forms of *T. carruthersi,* as is depicted in fig. 9, such as the breadth of the strongly striated mid-rib, the sinuous margins, and the secondary veins, about 7 to 10 per cm. going out at right angles. In the lower part of the pinnule the veins traversing the narrow lamina are wider spaced and more oblique. The examples come from Konings Kroon.

* Walkom, 1917, p. 34.

Walkom * has suggested that this narrow form is comparable with *T. tenison-woodsi*, but the latter is quite different, having the veins, for example, set at an acute angle to the mid-rib, and these South African leaves can be ascribed to *T. carruthersi* without much doubt.



TEXT-FIG. 9.—*Taeniopteris carruthersi*, Ten.-Woods. The secondary veins are shown at various points in the pinnules.

T. carruthersi is only recorded from the Ipswich Beds of Queensland and the Mesozoic of Tasmania, though the rather similar *T. vittata* has a much wider distribution, but the South African Museum has examples (Nos. 7127, 7137) from the " Rhaetic " of Barreal, Argentina, that are indistinguishable from *T. carruthersi*.

* Walkom, 1917, p. 34.

Taeniopteris nilssonioides, Zeiller.

Plate XVII, fig. 3.

1882. *Nilssonia polymorpha*, Zeiller, Ann. des Mines, vol. ii, p. 319, pl. xi, fig. 15 (*non* fig. 16).

1903. *Taeniopteris nilssonioides*, Zeiller, Flore foss. Tonkin, p. 78, pl. xv, figs. 1–4.

This peculiar form from the town of Dordrecht shows such distinctive features, that the fragments (5812) are figured in order to bring out the strong resemblance to the species of this name from Tonkin. They belong to a curiously wrinkled leaf from 9 to 10 cm. wide, with a moderately broad striated and pitted mid-rib or costa. The margin is uncommon in being very wavy, and, while evenly bordered in certain parts of the leaf, forms in others small lobes and sometimes distinct teeth with decidedly convex surfaces.

The strong veins, about 10 or 12 per cm., are given off at right angles, forking upon leaving the mid-rib and sometimes bifurcating thereafter, while in a few places near the border a vein after forking reunites to form a loop. Zeiller lays stress upon the fine intermediate veins in the Tonkin specimens, which cannot, however, be well seen except in the marginal parts of the lamina, where they appear on the ridges between the wrinkles, but in the Dordrecht plant only the faintest of threads can be made out between the well-defined veins next the margin, the parallel wrinkling not being so intense.

The main points of resemblance are nevertheless marked, and there can be no hesitation in referring this uncommon form to the species instituted by Zeiller, which is distinct from all other species of *Taeniopteris* that have yet been recorded (see p. 403).

Taeniopteris crassinervis (Feistmantel).

Plate XVII, fig. 2.

1877. *Macrotaeniopteris crassinervis*, Feistmantel, Palaeont. Indica., vol. i, pt. 2, p. 102, pl. xxxviii, figs. 1, 2, 2*a*, 2*b*, 3.

1883. ? *Macrotaeniopteris crassinervis*, Fontaine, Monogr. vi, U.S. Geol. Surv., p. 22, pl. v, fig. 5 ; ? pl. vi, figs. 1, 2.

1892. *Macrotaeniopteris crassinervis* ?, Etheridge, in Jack and Etheridge, Geol. and Pal. Queensland, p. 376, pl. xvi, fig. 5.

1898. *Macrotaeniopteris crassinervis*, Dun, Rep. Austr. Adv. Sci. Sydney, vol. vii, p. 398.

1917. *Taeniopteris crassinervis*, Arber, N. Zealand Geol. Surv., Pal. Bull. 6, p. 45, pl. ix, fig. 4; pl. x, figs. 1–3, 5.

1917. *Taeniopteris crassinervis*, Walkom, Queensl. Geol. Surv., Publ. 257, p. 39, pl. i, fig. 2.

1924. *Taeniopteris crassinervis*, Walkom, Mem. Queensl. Mus., vol. viii, pt. 1, p. 84, pl. xviii, figs. 1–3.

The rather curiously shaped frond, 8653, from the Waterfall, Upper Umkomaas Valley, Natal, figured here shows what is taken to be a young, immature leaf of this species, considerably shrivelled by the action of the sun prior to its burial. The mid-rib is broad, particularly in the basal part, longitudinally striated and slightly pitted. The thick, coriaceous lamina is most irregular in its outline, with curious lobings, and a remarkable contracted section at the base, while its edges show a markedly thickened and rigid border, revolute in places, a feature noted by Fontaine in the Virginian specimens.

The nerves are exceptionally strong, well raised and cord-like, actually consisting of two narrow strands with a slight depression between. They are widely spaced—almost a millimetre apart—emerge at right angles from the mid-rib, and are either single or bifurcate irregularly, while in several places two adjacent veins rejoin before reaching the margin, a character observed by Feistmantel in the Indian examples. Due to the withered nature of the leaf, and to the consequent wrinkling and distortion of the lamina, strict parallelism is wanting, more especially in the narrow and lobiform part of the pinnule.

The broad mid-rib and coarse, raised venation suffice to distinguish this form as *T. crassinervis*, known from the Rajmahal Beds of India, the Ipswich and Esk Series of Queensland, the Jurassic of New Zealand, and the Triassic—Lower Keuper—of Virginia. The affinities of the species and its possible identity with *Danaeopsis* have been fully discussed by Walkom,* and there is nothing further to add to his account.

Taeniopteris spatulata, M'cClelland.

=Taeniopteris daintreei, M'cCoy.

Text-figure 10, A, B, C.

(For synonymy see Seward, Rec. Geol. Surv. Victoria, vol. i, pt. 3, p. 168, and Walkom, Queensl. Geol. Surv., Publ. 257, p. 30.)

* Walkom, 1924, p. 85.

1889. *Taeniopteris daintreei*, Feistmantel, Abh. k. böhm. Gesell. Wiss. Prag., p. 66, pl. ii, fig. 11.

Feistmantel seems to have been justified in ascribing the small *Taeniopteris* fragment from Indwe to M'cCoy's species *T. daintreei.* The present collection has added a few similar examples differing from *T. carruthersi* but having to be placed under M'cClelland's species *T. spatulata*, which Walkom * has given reasons for considering as synonymous with *T. daintreei.*

The best example of these, 5810, fig. 10 A, from Dordrecht, shows the tapering base of the leaf with its stout mid-rib from which the secondary veins emerge at almost a right angle, about 15 per cm., forking as indicated in the enlargement B. This basal portion distinguishes the form from the similar *T. vittata.* Specimen 6200 from Konings Kroon, Elliot, displays an apical portion C with the veins diverging at a sharper angle as the tip is approached. Fragments of other examples are 5811 from Dordrecht, 10n from the farm Tarka near Indwe, and 287f from the top of the Cala Pass.

T. spatulata occurs in the Rajmahal Beds of India,† but is widespread in Australia both in the Ipswich and Walloon Beds of Queensland,‡ Jurassic of New South Wales § and Victoria,|| and Rhaetic of New Zealand.¶ The forms described under this specific name by Zeiller from Tonkin ** display an unusual wrinkling of the lamina.

TAENIOPTERIS cf. IMMERSA, Nathorst.

Text-fig. 10, D.

1878. *Taeniopteris* (*Danaeopsis ?*) *immersa*, Nathorst, Floran vid Bjuf, p. 45, pl. i, fig. 16.

1903. *Taeniopteris* cf. *immersa*, Zeiller, Flore foss. Tonkin, p. 293, pl. liv, fig. 5.

The thick, coriaceous leaf, 8660, is broad and oval with a blunt, rounded apex very slightly re-entrant, rather like that in the species *T. jourdyi*, Zeiller, from Tonkin, and with an undulating margin; the base is not preserved. Mid-rib fairly broad, narrowing rapidly

* Walkom, 1917, p. 31.

† Oldham and Morris, 1863, p. 34, pl. vi, figs. 1–6.

‡ Walkom, *loc. cit.*

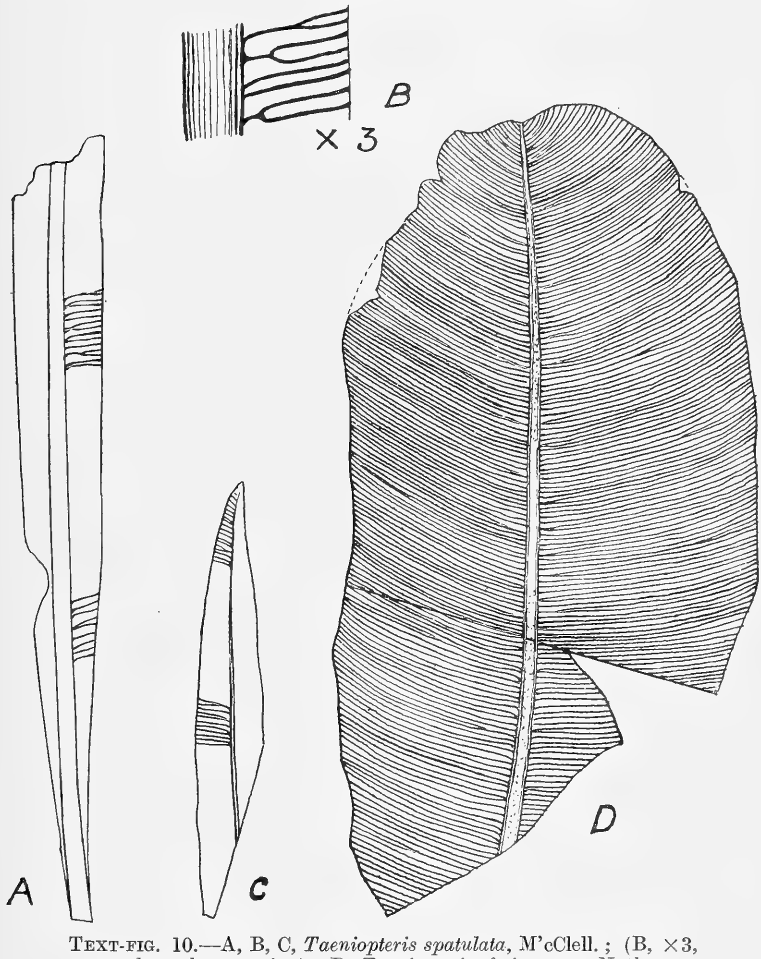
§ Feistmantel, 1890, p. 114, pl. xxvii, figs. 4, 5; pl. xxviii, figs. 6, 6*a*.

|| Seward, 1904, p. 168.

¶ Arber, 1917, p. 46, pl. vi, fig. 5.

** Zeiller, 1903, p. 74, pl. xiii, figs. 6–12.

towards the summit, finely striated and with minute protuberances. The strong parallel secondary veins, 15 per cm., are set in the bottom of grooves, are given off from the mid-rib at right angles, and then



TEXT-FIG. 10.—A, B, C, *Taeniopteris spatulata*, M'cClell.; (B, ×3, to show the venation); D, *Taeniopteris* cf. *immersa*, Nath.

curve evenly upwards towards the margin; at the apex the curvature is more pronounced. The majority of the veins are single, but about every fifth or sixth one bifurcates, generally upon leaving the mid-rib. A remarkable character is produced at six places in the leaf through the re-union of pairs of veins just before reaching the margin, this rare feature having been observed by Feistmantel in *Taeniopteris*

(*Macrotaeniopteris*) *crassinervis* from the Rajmahal Beds.* Indeed the two forms are much alike, but in that species from South Africa, India, Queensland, and New Zealand there is a much more widely spaced venation and a lesser curvature, characters reckoned to be of specific importance.

Except for size it approaches the huge *T. feddeni* (Feist.) from the Raniganj Beds,† the closely-set veins, both simple and forked, of which show a similar forward curvature, though not to the same degree, while a second species from the Rajmahal Beds, with which it exhibits important resemblances, is *T. lata*, Old.,‡ though here again the fronds are of large size.

The plant, which comes from the Molteno Beds at the Waterfall, Upper Umkomaas Valley, Natal, agrees very well with the form *T. immersa* described by Nathorst from the Rhaetic Beds of Bjuf, though the apex of his type has not been preserved; on the other hand the leaf figured by him on his plate xix, fig. 6, as a variety thereof has little resemblance and can scarcely belong to the same species. Zeiller has referred to *T.* cf. *immersa* a large form from China,§ which has a strong likeness to the Natal fossil, but its veins do not leave the mid-rib exactly at right angles, while they furthermore run on ridges. Wieland has reported large leaves from Jurassic strata in Mexico ‖ so like the Chinese examples that he has separated them from *T. immersa* under the name of *T.* (*Zeilleri*) *tonkinensis*. Seeing that these American forms are better known than the fragmentary type from Bjuf, such a decision has something to recommend it, but the South African plant has its secondary veins curving very much more, not to mention their arrangement in grooves, both of which are prominent features in the Swedish fossil.

With no other European form is it in any way comparable, wherefore, rather than institute a new species, it is provisionally associated with *T. immersa*, with which it may prove identical.

Taeniopteris cf. brackebuschiana (Kurtz).

Text-figure 11, A, B.

1921–22. *Oleandridium brackebuschianum*, Kurtz, Actas Acad. Nac. Cien. Córdoba, p. 129, pl. xvii, fig. 307; pl. xxi, figs. 147–150, 302, 304–306, 308.

* Feistmantel, 1877, p. 50, pl. xxxviii.

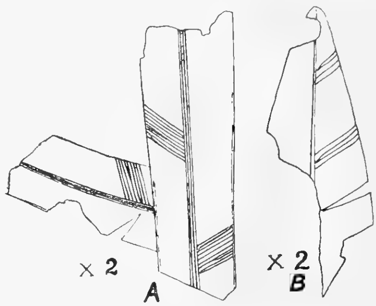
† *Ibid.*, 1881, p. 89, pl. xxiiA.

‡ Oldham, 1862, pls. i, iii, fig. 2.

§ Zeiller, 1903, p. 292, pl. liv, fig. 5.

‖ Wieland, 1914, p. 132, pl. xliii.

Among the various portions of *Taeniopteris* leaves are two that belong to a strap-shaped pinnule quite distinct from any other South African species. These are on a slab, 6192, from Konings Kroon, Elliot (fig. 11, A). The terminations are not preserved, but in the specimen, 8645 from half-way up the Cala Pass (fig. 11, B), an identical venation is present, wherefore the pinnule is presumed to have narrowed to a blunt point. The example 14g from Dordrecht is furthermore taken to represent the base of this species contracting regularly towards the petiole.



TEXT-FIG. 11.—A, B, *Taeniopteris* cf. *brackebuschiana* (Kurtz).

The important features are the narrow width (only just over 1 cm.), the strong mid-rib (which shows pitting), the acute angle (45–55 degrees) which the secondary veins make, their closeness (20–24 per cm.), their course nearly straight to the margin, their commonly simple character, the occasional junction of two adjacent veins near the edge of the pinnule, and the presence of a marginal vein.

Such characters, it can be stated, are to be found in more or less marked degree in several well-known species from Europe, Queensland, or Argentina, and it is therefore not easy to make a positive identification in the absence of complete leaves. The form which it approaches most nearly is one from the "Rhaetic" of Argentina named *Oleandridium brackebuschianum* by Kurtz, but without any description, and known only from the figures prepared by him and issued posthumously. These show the same narrow pinnule, the same acute angle of the secondary veins and their occasional reunion, as well as the marginal vein.

The form is somewhat narrower than *T. mareyesiaca*, Gein., from the same formation (also figured by Kurtz), but which shows the straight and sometimes forking veins emerging at angles of only 70 degrees, with occasional reunion and with a marginal vein. Indeed it is questionable whether this and Kurtz's species are not varieties. Rather like *T. mareyesiaca*, too, is *T. lentriculiforme* (Eth. Jr.) * from the Ipswich Beds of Queensland, while the species separated off by Walkom from the former as *T. dunstani* † is indistinguishable from

* Etheridge, Jr., 1894, p. 49, pl. viii, figs. 1–3

† Walkom, 1917, p. 37, pl. ix, fig. 1

this Argentine form. I am indeed inclined to consider them as one and the same, the venation being identical, even to the occasional reunion of adjacent veins and the presence of a marginal vein.

The South African pinnules also recall *T. tenuinervis*, Braun,* and *T. stenoneura*, Schenck,† from the Rhaetic of Germany with their wider-spaced secondary veins set at angles of between 60 and 70 degrees. A marginal vein is absent in the first, nor do any veins ever reunite, while in the second the apex is rounded and the veins, after emerging at an acute angle, curve slightly forwards.

Although his untimely death prevented Kurtz from issuing the description of *T. brackebuschiana*, we are justified in accepting his illustrations as representing the joint types of a new species, with which the Molteno forms compare very closely and are possibly identical.

Genus STORMBERGIA, Seward.

Stormbergia gardneri, Seward.

1911. *Stormbergia gardneri*, Seward, Geol. Mag., vol. viii, p. 298, pl. xiv; reprinted in 1912 in Ann. Albany Museum, vol. ii, pt. 4, p. 284, pl. xiv.

This bipinnate frond from Cyfergat is unusual in that the pinnules are borne on short stalks and are traversed by a few simple or forked veins arising at wide intervals from the mid-rib. I have re-examined the specimen and carefully developed it somewhat further, the outcome of which is to suggest that the pinnule was thick and fleshy, pod-like in character, bounded by a marked marginal vein. The upper surface appears to have been convex and nearly smooth, the mid-rib and secondary veins lying embedded in the middle and lower parts of the tissue, as shown by the clear impressions of the under surface of the lamina on the shale. The friable carbonaceous substance of the leaf was treated with nitric acid and potassium chlorate, but failed to leave any residue.

The affinities of this plant are unknown, but it would appear premature to place it among the Filicales.

The specimen, No. 3694, is in the Albany Museum, Grahamstown.

* Schenck, 1867, p. 101, pl. xxv, figs. 3, 4.

† *Ibid.*, 1867, p. 103, pl. xxv, figs. 5, 6.

Genus SPHENOPTERIS, Brongniart.

Sphenopteris lobifolia, Morris.

Text-figure 12, A, B.

1845. *Sphenopteris lobifolia,* Morris, in Strzelecki's New South Wales, p. 246, pl. vii, figs. 3, 3*a*.

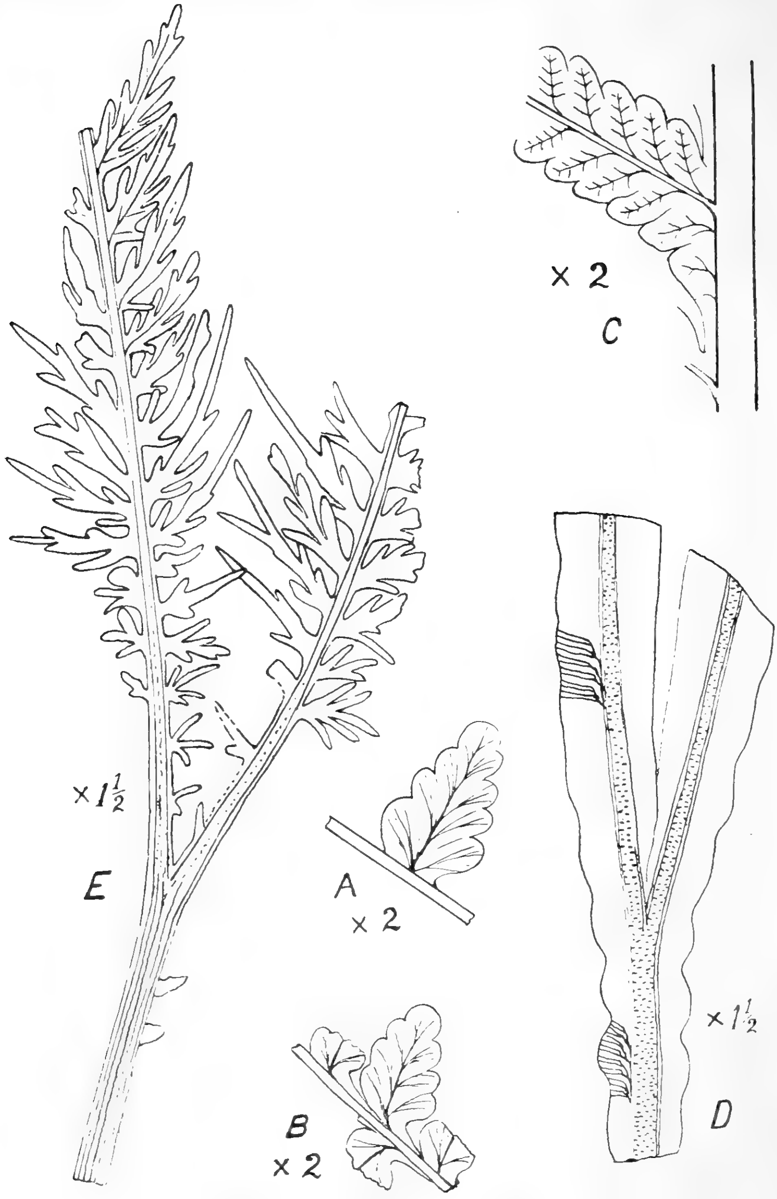
(For synonymy see Arber, Glossopteris Flora, 1905, p. 135, pl. v, figs. 2, 2*a*, 3.)

On the slab, 8326, from the Molteno Beds at the Waterfall, Upper Umkomaas Valley, Natal, are several impressions, doubtless parts of one and the same frond, having delicate lobate pinnules going out at a little less than a right angle, and set generally opposite or sub-opposite. The pinnules vary in size and shape according to their position in the frond. For instance, one of the larger individuals, figured in A, is somewhat contracted at the base, showing from 3 to 4 rounded lobes on either side and 1 lobe at the extremity. The secondary veins are given off from the straight mid-vein nearly opposite to one another, dividing immediately to give from 2 to 4 veins at the margin. Progressing along the frond the pinnules become decurrent (fig. B), while the terminal ones are not only smaller and only slightly lobate, but are strongly decurrent and quite oblique to the rachis.

This form, the only one yet known from the Molteno Beds, recalls *S. polymorpha* from the Permian of Australia and India, but is more like Morris' *S. lobifolia,* with which it can be identified, though the lobing in the New South Wales specimen is a little deeper and the pinnules are nearly alternate. Arber * has also described this species from the Clarke Collection of Australian plants at Cambridge, and, while the Natal plant agrees well with his description, it fits still better with Morris's original account and figure. *S. lobifolia* comes from the Newcastle Coal Measures of New South Wales and from the Lower and Upper Bowen Series of Queensland,† both Lower Permian, but has also been recorded from the Mesozoic of Tasmania ; it is not known outside Australasia.

The Natal form, however, also comes very close to *S. augusti* and *S.* cf. *lebachensis* (Weiss) from the Permian of Saxony.‡

* Arber, 1902, p. 11.
† Walkom, 1922, p. 9.
‡ Stertzel, 1886.



TEXT-FIG. 12.—A, B, *Sphenopteris lobifolia*, Morr., ×2; C, *Callipteridium africanum*, sp. nov., ×2; D, *Johnstonia coriacea*, Walk, ×1½; E, *Stenopteris elongata* (Carr.), ×1½.

Genus CALLIPTERIDIUM, Weiss.

Callipteridium africanum, sp. nov.

Plate XXII, fig. 1 ; text-figure 12, C.

Five examples from Konings Kroon, Elliot, agreeing very closely in their habit, show in marked degree characters that are peculiar to the Palaeozoic genus *Callipteridium.*

One of them, 6617, has been figured in Plate XXII, which is of a bipinnate frond having a very stout rachis, from which the opposite or sub-opposite linear pinnae or segments are given off at angles of about 50 or 60 degrees, and which are quite small at the base of the frond, while one of the others, 5913, represents a more apical portion of the same plant with more widely spaced segments, decreasing in size and becoming more forwardly directed distally. Characteristic are the decurrent and auricled bases of the pinnae, the pinnules being continued on to the rachis with curving veins entering into these lobings directly from the latter.

The pinnae are peculiar in that they are composed of concrescent pinnules, decreasing regularly in size towards the apex, so that the margins of the pinnae may be almost smooth, or at the most only slightly serrate or dentate, the lamina thereof being continuous; rarely can the sides be seen of any of the pinnules, and normally they appear to be fused together. In the enlargement, text-fig. 12, C, of part of specimen 5914 the serrate margin is unusually well developed, and the venation is also less difficult to make out. The primary veins are well marked, somewhat oblique to the pinna rachis, and decurrent, and at first sight the pinna has a strong resemblance to a single pinnule with single parallel, oblique secondary veins. Where the state of preservation is better, the true secondary nerves can be made out, being given off at a relatively wide angle, a pair emerging on either side of the primary vein at the same point; only rarely do they appear to bifurcate. The venation is hence Pecopterid. These features are also well seen in the examples from the Beaufort Beds described on p. 404.

Such uncommon characters are practically confined to the genera *Callipteris* and *Callipteridium*, the bipinnate and unforked habit, the reduction in size of the pinnae towards the base of the frond, and the nature of the secondary venation agreeing better with the latter. The form differs widely from *Callipteridium stormbergense*, Seward,*

* Seward, 1903, p. 58, pl. vii, figs. 4–6*a*; pl. viii, fig. 5.

common in the Molteno Beds, in which the serrated pinnules are confluent at their bases, but otherwise openly set, and are only crowded in the distal region of the pinnae and near the apex of the frond; the main rachis, furthermore, carries separate pinnules, a feature absent from all the examples under consideration. There is only a general agreement with the Permian species *Callipteris conferta* and *Callipteris pellati*, and under the circumstances a new specific name becomes necessary.

There is, however, a very marked resemblance with certain sterile fronds of the plant from the Triassic of Virginia named by Fontaine * *Asterocarpus virginiensis*, in which appears the same type of pinnatifid pinnae showing lobing at their lower base, with the veins entering into the latter directly from the stout rachis, while the pinnules are to a considerable degree fused together, more especially in the apical portions. This decurrent and lobed character of the pinnae is, however, not always present there, though invariable in the South African examples. The fertile pinnules in the Virginia plant bore a double row of sori, and that form almost certainly belongs to the ferns, whereas *Callipteridium* is probably a pteridosperm; the specimens from Elliot show no evidence of sori.

The examples of this species are 5913, 5914, 5915, and 6617; 5912 is in the Sedgwick Museum, Cambridge.

Genus JOHNSTONIA, Walkom.

Johnstonia coriacea, Walkom.

Text-figures 12, D; 13, B.

1925. *Johnstonia coriacea*, Walkom, Roy. Soc. Tasmania: Pap. and Proc., 1924, p. 79, figs. 6–8.

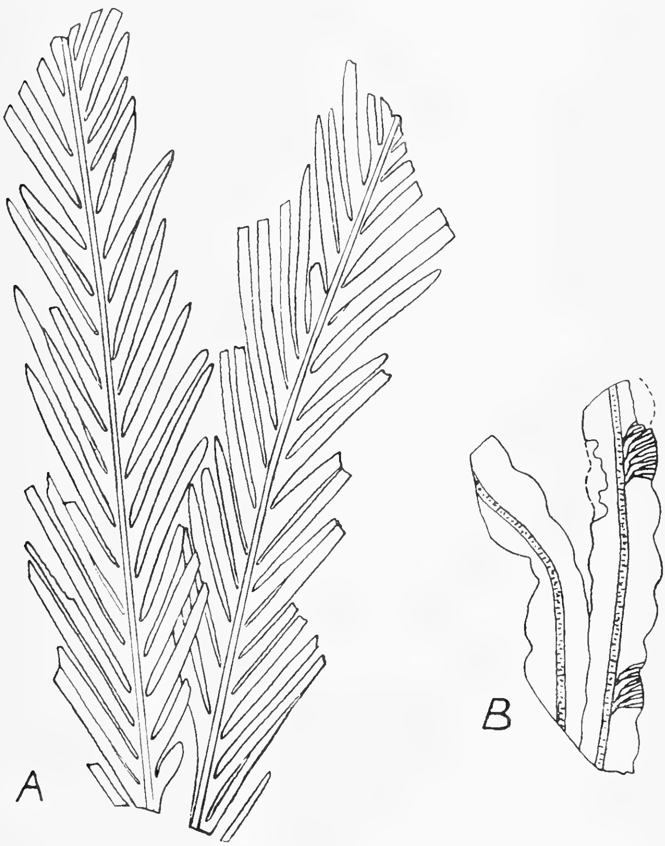
This peculiar fragment, 8261, text-fig. 12, D, from the Waterfall, Upper Umkomaas Valley, Natal, belongs to a dichotomously branched frond, having a continuous lamina with slightly lobed margins, especially in the proximal portion. Within the fork the inner edges of the lamina are more even, and one of them overlaps the other slightly.

The veins emerge at an acute angle from the exceptionally broad, wrinkled, and transversely pitted rachis, bifurcate and then bend outwards, usually forking once again. They are not perfectly

* Fontaine, 1883, p. 41, especially pl. xx.

regular as in a *Taeniopteris* pinnule, the presence of the slight lobings causing corresponding divergences of the veins wherever the margins of the lamina show indentations.

From the same locality, though probably not forming a part of the



Text-fig. 13.—A, *Stenopteris densifolia*, sp. nov. ; B, *Johnstonia coriacea*, Walk.

example just described, comes a second specimen, 403u, text-fig. 13, B, which displays the continuation of two segments just above the point of forking, each with the same characteristic lobings and the doubly forking veins.

There is some similarity with the apical portion of a *Danaeopsis* frond, but the venation characters and the regularly lobed margins of the Natal plant serve to distinguish the latter from *Danaeopsis*.

This uncommon form is, however, practically identical with the plant described under this name by Walkom from the Mesozoic of Tasmania. The apical portion of a second frond, 34g, and its counterpart, 35g, from Maudesley, Lady Grey, bear a considerable resemblance to Walkom's fig. 8 of this species, and may just possibly belong to that form, though not improbably representing the termination of a pinna of *Pachypteris*.

Genus STENOPTERIS, Saporta.

Stenopteris elongata (Carruthers).

Plate XIX, fig. 1; text-figure 12, E.

1872. *Sphenopteris elongata*, Carruthers, Quart. Journ. Geol. Soc., vol. xxviii, p. 355, pl. xxvii, fig. 1.
1903. *Stenopteris elongata*, Seward, Ann. S. Afr. Mus., vol. iv, pt. 1, p. 70, pl. xi, fig. 3.
1917. *Stenopteris elongata*, Walkom, Queensl. Geol. Surv., Publ. 257, p. 40, pl. i, fig. 1; pl. vi, figs. 1–4*a*.

(For synonymy see Seward and Walkom.)

This form is common in the Molteno Beds, usually as fragments of a dichotomously divided frond with extremely narrow linear segments set at an angle of about 45 degrees to the rachis. Walkom's work on the Queensland examples, together with the new material to hand, suggest a polymorphic species, since an almost complete series of forms is recognisable between fronds with simple, narrow linear segments and those having conspicuously lobed or indented pinnules, as shown in the accompanying illustrations.

In the majority of these the segments are no broader than the striated rachis to which they are attached, and are commonly subopposite, though not unusually unequally spaced, and sometimes of slightly unequal widths. There are several markedly symmetrical examples represented from Natal, which recall *S. rigida*, Dun,* from Dubbo, New South Wales, and from which I can see no essential points of difference. Seward mentions the absence of a well-defined median vein from the segments in the majority of the examples examined by him, but the bulk of those collected since show such a feature, often very well, and which, according to Walkom, is characteristic of the Queensland forms. Not unlikely the differences

* Dun, 1909, pl. i, figs. 1, 2.

noted are largely due to conditions in fossilisation, such as to the degree of the drying out of the woody fronds before their entombment, and little weight ought to be set on the presence or absence of a median vein as representing a specific character.

Plate XIX, fig. 1, represents a frond, 8252, in which the basal parts of the pinnules show fine lobings, continued into a narrow segment, while the median vein, which runs to the apex, gives off secondary veins into each of the lobes, in one or two instances at least bifurcating. This drawing should be compared with Walkom's * photographs of similar fronds from the Ipswich Beds of Queensland.

The dichotomous example on dark shale, 8320, from Duart Castle, Hlatimbe Valley, Natal, reproduced in text-fig. 12, E, reveals a form in which the lower pinnules are conspicuously digitate, the middle ones like those in the last cited case, and the distal ones markedly lobate, with the secondary veins passing into each of the lobes. Fragments of these apical pinnules could readily be mistaken for either *Sphenopteris* or *Pachypteris*.

The affinities of *Stenopteris* are still in doubt. The dense and "woody" appearance of the rachis and segments renders it rather unlikely that *Stenopteris* belongs to the ferns, as Saporta † long ago noticed. Attention should therefore be drawn to the striking likeness displayed between Plate XIX, fig. 1 or text-fig. 12, E, and examples of *Pachypteris incisa* in the structure of the frond, the attachment of the pinnules and their venation. This is interesting, since from the structure of the epidermis Gothan ‡ has referred to *Thinnfeldia* the form *T. schwarzi* from the Rhaetic of Nürnberg, which has undoubted *Stenopteris*-like characters, and which Antevs § has indeed regarded as belonging to that genus. A preparation of the cuticle of the very similar *S. densifolia*, viewed from beneath, shows, text-fig. 14, B, the central zone overlying the median nerve with its nearly rectangular elongated cells, flanked by belts with polygonal cells, having straight or undulose walls and stomatal openings, and finally the outer thickened pinnule edge. The stomata are smaller in comparison with the cells than in *Thinnfeldia*, and the accessory cells do not form so regular a ring around the two guard-cells. In certain of the examples from this locality the untreated carbonised striated rachis reveals under a high magnification vertical rows of cork cells.

* Walkom, 1917, pl. vi, figs. 1, 3, 4*a*.

† Saporta, 1873, p. 291, p. 297.

‡ Gothan, 1914, p. 121.

§ Antevs, 1914, p. 47, p. 62.

Stenopteris densifolia, sp. nov.

Text-figures 13, A; 14, A, B.

In contrast to the various examples of *S. elongata*, both from this country and Australia, in which the segments are invariably widely though often irregularly spaced, is the specimen, 6626, of a bifurcating frond, one of several from Konings Kroon, Elliot, in which the pinnules are so crowded that they are almost in contact at their base and are also more acutely set. They are furthermore not always of equal widths and range from opposite to alternate in different parts of the frond. The alate character of the longitudinally striated rachis becomes noticeable within the fork, where the first pinnule is small and markedly decurrent. The terminations of the segments, where preserved, are lanciform, each being traversed by a well-marked and relatively broad secondary vein, persistent to the apex, and in favourable places seen to be composed of several strands, text-fig. 13, A.

Text-fig. 14, A, is of a slab of shales, 8265, from the Waterfall, Upper Umkomaas Valley, Natal, showing two dichotomous fronds ascribed to this species, which probably belong to the same stem; one of them forks a second time. The plant displays in the mid-frond features somewhat similar to those characterising *S. elongata*, namely the lobate nature of many of the pinnules in that section. In this species it takes the form of a single, lesser lobe or lanciform pinnule branching out from the lower angle of the main pinnule, which off-shoot is also provided with a strong nerve leaving the main one close to the rachis. The epidermis of this particular example is illustrated in text-fig. 14, B, which has been described above.

As has just been pointed out above, *S. elongata* is decidedly polymorphic, and, while future collecting may show the advisability of including the present form under that species, the crowding together of the segments is so distinctive and unusual as to demand at least a varietal, if not a new, specific title. Provisionally, therefore, the plant can be named *S. densifolia.*

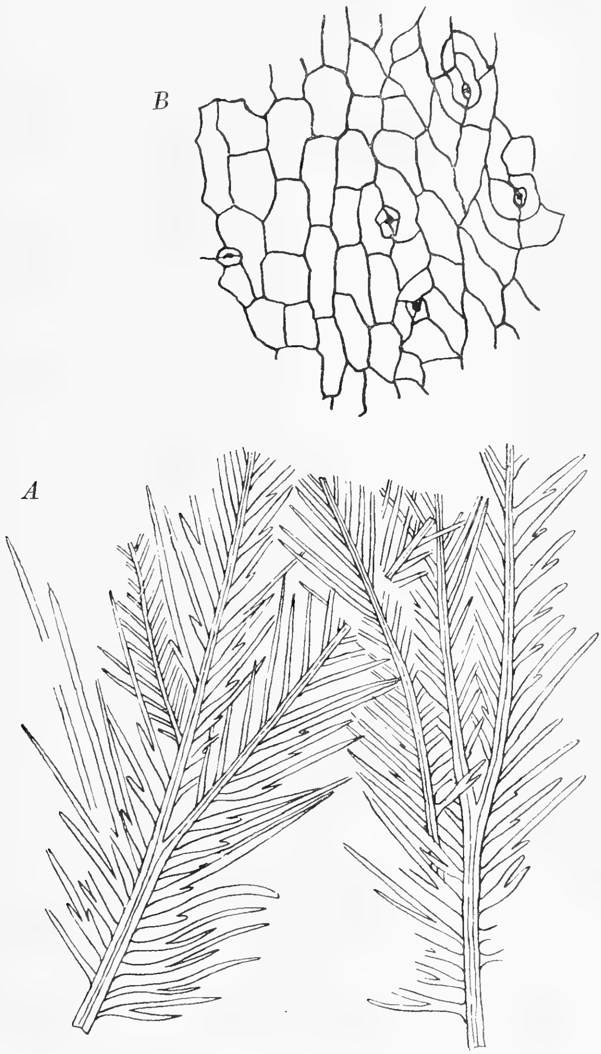
Genus GLOSSOPTERIS, Brongniart.

Glossopteris conspicua, Feistmantel.

Text-figure 15, A.

1881. *Glossopteris conspicua*, Feistmantel, Palaeont. Indica., Gondw. Flora, vol. iii, pt. 3, p. 104, pl. xxviiiA, figs. 1, 5, 6, 8, 9.

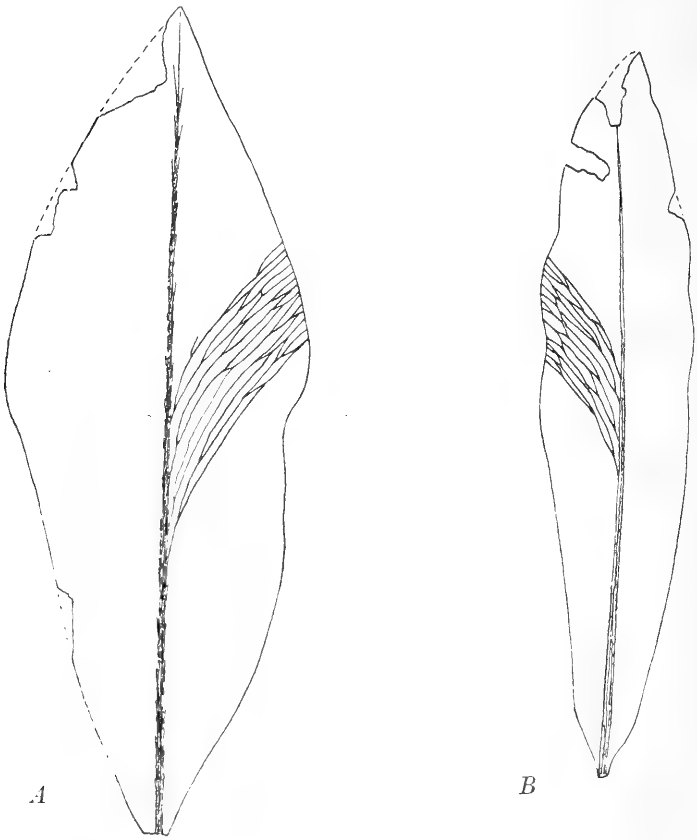
1905. *Glossopteris conspicua*, Arber, The Glossopteris Flora, p. 86, pl. iii, fig. 3.



TEXT-FIG. 14.—A, B, *Stenopteris densifolia*, sp. nov. ; B, cuticle, highly magnified.

Frond fairly large, oval-lanceolate with striated mid-rib, thick at base and persisting almost to the apex ; secondary veins given off at an acute angle, gently arched near mid-rib and then running parallel

towards the margin. Cross-connections not very numerous, but more frequent towards the edge of the lamina, giving open, elongate meshes much longer than broad, which occasionally extend from the mid-rib almost to the margin.



TEXT-FIG. 15.—A, *Glossopteris conspicua*, Feist.; B, *Glossopteris browniana*, Brong.

Except for the slightly acuter apex the frond, 8325, agrees well with that of *G. conspicua*, as figured by Feistmantel from the Damuda Series (see especially his fig. 5). This comparison is interesting, because in India this uncommon species is not known from an horizon above the Damuda, while in South Africa it has been recorded only from the upper part of the Lower Beaufort Beds at the Mill (Molen) River Drift near Harrismith, additional individuals having been

identified from the same horizon below the Inhluzani Mountain in Natal by the writer. In these undoubted Lower Beaufort forms the meshes are not quite so long in proportion to their width or to that of the frond as in the specimen from the Molteno Beds, which is from the Upper Umkomaas Valley, Natal. Other examples, 377u, 400u, 8308, and 8309, from the same locality, also have elongate-polygonal meshes.

Glossopteris browniana, Brongniart (pars).

Text-figure 15, B.

This specimen, 404u, also from the Upper Umkomaas Valley, Natal, shows a narrow lanceolate frond contracting rapidly towards the base and having a persistent mid-rib. The secondary veins curve a little more than in *G. conspicua*, and are set much closer together, otherwise the pattern is very similar, especially by reason of the simple bifurcation near the mid-rib with consequent elongate meshes.

Though not typical of *G. browniana*, the venation is like that of the variety *praecursor* created by Feistmantel * for some fronds from the Greta Series of New South Wales.

Other examples are 377u and 406u from the Waterfall locality.

G. browniana has hitherto been recorded from the Molteno Beds only at the Fair View Mine, near Cyfergat in the Stormberg, the specimen, V, 3256, being preserved in the British Museum.† The only other association of *Glossopteris* with the Thinnfeldia Flora is in Tonkin, whence Zeiller has recognised *G. angustifolia* and *G. indica*,‡ both of which possess a closer venation, though one of his examples of *G. indica* § also has the long, open meshes adjacent to the mid-rib. Wieland || has figured from the Liassic of Mexico a long pinnule under the name of *Glossopteris* (?) *linearis*, but, from the somewhat undulose margins and the way in which the mid-rib seems to fade out in the figure, it can be suggested that this is a *Sagenopteris*. The Molteno Beds provide the only instance yet known of the survival of *Glossopteris browniana* into Trias-Rhaetic times.

* Feistmantel, 1890, p. 122, pl. xiii, figs. 5, 6.

† Arber, 1905, p. 61.

‡ Zeiller, 1903, pp. 83–88, 296–298 ; pl. xvi, figs. 2–5 ; pl. lvi, figs. 1, 2.

§ *Ibid.*, 1903, pl. xvi, figs. 2, 2*a*.

|| Wieland, 1914, p. 135, pl. xvii, fig. 2.

PLANTS OF DOUBTFUL POSITION.

Genus PHOENICOPSIS, Heer.

Phoenicopsis elongatus (Morris).

1845. *Zeugophyllites elongatus,* Morris in Strzelecki's New South Wales, p. 259, pl. vi, figs. 5, 5*a*.
1888. *Zeugophyllites elongatus,* Szajnocha, Foss. Pflanz. Cacheuta, Argent. Republ., pl. ii, fig. 4.
1889. *Podozamites elongatus* Feistmantel, Abh. k. böhm. Gesell. Wiss. Prag., vol. iii, pt. 7, p. 68, pl. ii, fig. 13; pl. iii, figs. 3, 4, 7.
1903. *Phoenicopsis elongatus,* Seward, Ann. S. Afr. Mus., vol. iv, pt. 1, p. 67, pl. ix, figs. 1, 9, 10.
1917. *Phoenicopsis elongatus,* Walkom, Queensl. Geol. Surv., Publ. 259, p. 27, pl. ix, figs. 2, 3.
1921–22. *Podozamites elongatus,* Kurtz, Actas Acad. Nac. Cien. Córdoba, pl. xviii, 246a; pl. xxi, 181, 183–6, 315, 318, 320; pl. xxii, 316.
1925. *Phoenicopsis elongatus* Walkom, Roy. Soc. Tasmania, p. 87.

To Seward's full account there is nothing to add. It is a curious fact that in none of the specimens yet obtained in South Africa have any of the leaves been found attached to an axis nor do they ever display an undoubted base. Several examples bear a considerable resemblance to certain species of *Podozamites,* and it is not at all unlikely that this genus is actually represented among the fragments at present ascribed to *Phoenicopsis.* Morris' species is known from the Mesozoic of Queensland, Tasmania, and Argentina.

D.—GINKGOALES.

Genus GINKGOITES, Seward.

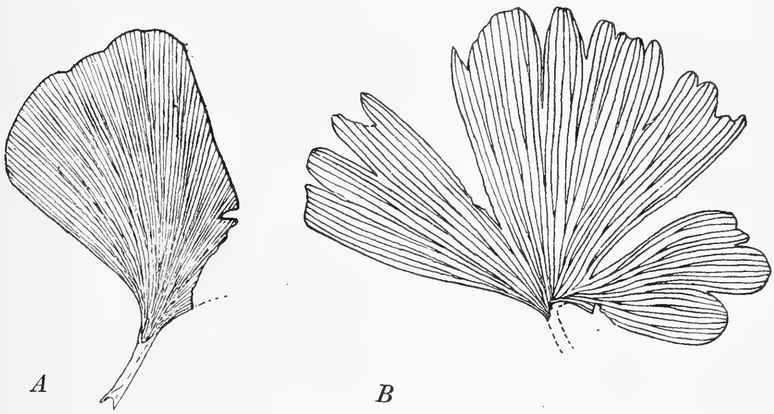
Ginkgoites antarctica (Saporta).

Text-figure 16, A.

1885. *Salisburia antarctica,* Renault, Cours de Botanique Fossile, vol. iv, p. 57, pl. ii, fig. 19.
1898. *Ginkgo antarctica,* Shirley, Queensl. Geol. Surv., Bull. No. 7, p. 11, pl. i, fig. 1.

1917. *Ginkgo antarctica*, Walkom, Queensl. Geol. Surv., Publ. 259, p. 7, pl. i, figs. 1, 2.

This incomplete specimen, 8328, and counterpart 445q, from the town of Maclear, belong to a simple leaf with short petiole having an even or but slightly crenulate margin, with possibly a medial sinus as in the living *Ginkgo biloba.* It is moreover characterised by the extreme closeness of the dichotomising veins, which bifurcate in the



TEXT-FIG. 16.—A, *Ginkgoites antarctica* (Sap.); B, *Ginkgoites digitata* (Brong.).

regular *Ginkgo* fashion, several per millimetre. The lamina is very thin.

The form agrees well, except for its much finer venation, with the fossil described from New South Wales by Renault as *Salisburia antarctica* and with the leaves figured as *Ginkgo antarctica* from the Ipswich Series by Shirley and Walkom, discussed by Seward * and placed by him under the generic title of *Ginkgoites* in accordance with recent custom.

GINKGOITES MOLTENENSIS (Seward).

1908. *Baiera moltenensis*, Seward, Quart. Jour. Geol. Soc., vol. lxiv, p. 99, pl. ii, fig. 4.

As Seward has remarked, this form might equally well have been included in the genus *Ginkgoites* rather than in *Baiera.* The leaf certainly differs from the majority of forms referred to *Baiera* through having an only partially dissected lamina, and, granted that an

* Seward, 1919, vol. iv, p. 13, fig. 632, B.

extreme degree of dissection constitutes the determining factor of generic distinction, the plant should more correctly be placed under *Ginkgoites*.

It is more cuneate than any deeply dissected varieties of *G. digitata* and is more like *G. schmidtiana*, Heer, var. *parvifolia*, Krasser,* from the Jurassic of Mongolia, or, as Seward † has pointed out, *Baiera australis* from the Jurassic of Victoria, but is unlike *B. guilhaumati*, *G. sibirica*, or *G. flabellata*.

The fossil comes from the Molteno Beds of Dordrecht.

Ginkgoites digitata (Brongniart).

Text-figure 16, B.

(For synonymy see Seward, Mem. and Proc. Manchester Lit. and Phil. Soc., 1899–1900, vol. xliv, p. 23, pl. ii, fig. 5.)

From the town of Maclear three slabs of shale have been collected showing impressions of this species, one of which, 8671, figured here, represents a nearly complete leaf with only the slender petiole missing. The lamina, which is very thin, has been torn in two places, but the margin is only slightly incised, the leaf being thus fan-shaped with a number of small lobings, far more numerous, however, than in *G. huttoni*; the bifurcating veins are just under 1 mm. apart.

In every respect these forms agree with *G. digitata*, a very widespread species, known from the Permian,‡ Upper Triassic, but principally from the Rhaetic or Jurassic in many parts of the world, for instance in England, Spitzbergen, Bornholm, Russia, Siberia, Japan, Oregon, Alaska, Queensland, and Tasmania, and it is therefore of interest to have this species recorded for the first time in South Africa. The relationship of this fairly well-defined species to the forms designated as *G. magnifolia*, regarding which there are differences of opinion, will be dealt with below. Another example of this form is 454q.

Ginkgoites magnifolia (Fontaine).

Plates XX, XXI, fig. 1; text-figure 17

1903. *Baiera stormbergensis*, Seward, Ann. S. Afr. Mus., vol. iv, p. 64, pl. viii, fig. 3.

* Krasser, 1905–6, p. 604, pl. ii, figs. 4, 5.

† Seward, 1904, pl. xviii, figs. 36, 37.

‡ Zalessky, 1918, pl. xlviii, figs. 3, 4.

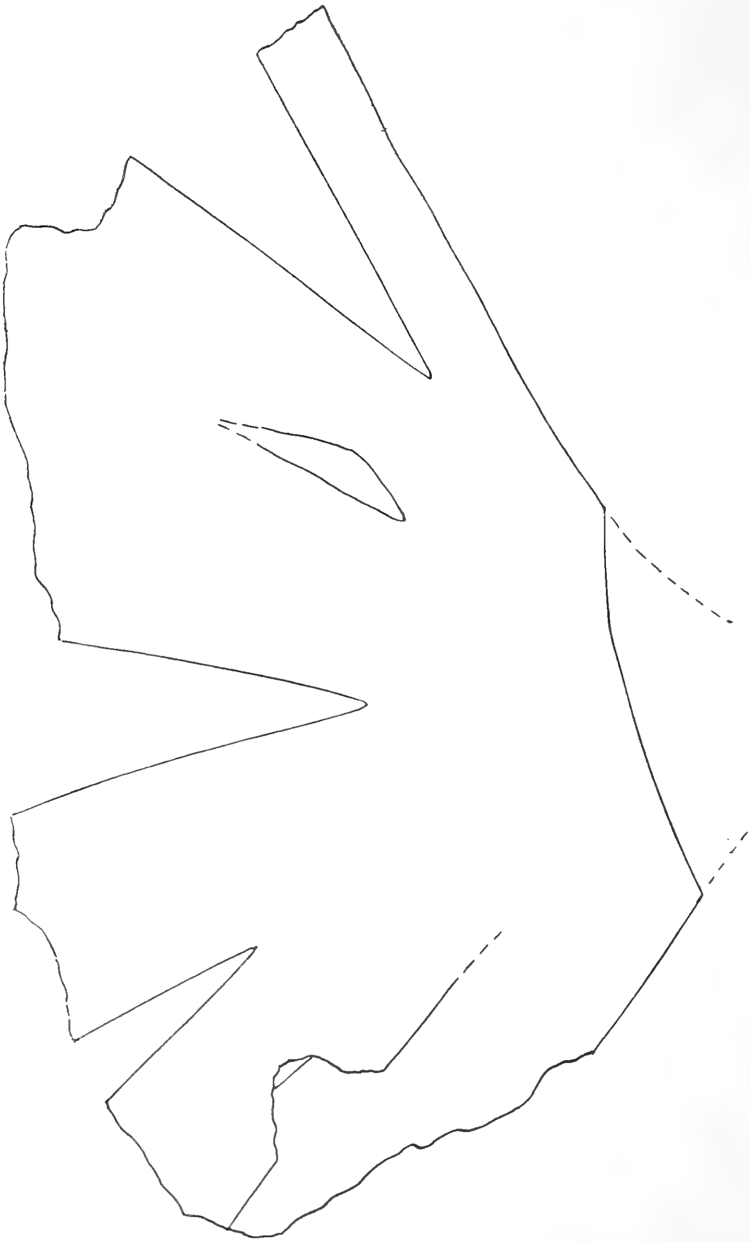
1905. *Ginkgo Huttoni magnifolia,* Ward, U.S. Geol. Surv., Monog. xlviii, p. 124, pl. xxxi, figs. 6, 8 ; pl. xxxii, figs. 1, 2.

1917. *Ginkgo magnifolia,* Walkom, Queensl. Geol. Surv., Publ. 259, p. 9, pl. iv, figs. 3, 4.

In 1903 Seward described a fragment of a very large Ginkgo-like leaf from Konings Kroon, Elliot, as a new species of *Baiera,* with the remark that it might with equal propriety be included in the genus *Ginkgo.* Further collecting from the same fossiliferous flinty band has led to the acquisition of a number of leaves, the smaller ones nearly complete, but the larger ones of so remarkable a size that in no case did a slab contain a complete example. The greatest is indeed 20 cm. in breadth with its full size unknown, 8253, text-fig. 17, while the example reproduced in Plate XX, 8254, could not have been less than 20 cm. in length ; the segments moreover frequently exceed 3 cm. in width (see also p. 405).

The South African fossils, which occur packed one upon another along certain layers, are of much greater dimensions even than the unusually large leaves figured by Ward from the Jurassic of Oregon, and are probably unique in their size. They resemble the type known as *G. huttoni*—regarded by Seward as a variety of *G. digitata,* but with more reason held by both Fontaine and Ward as a distinct species—in that the leaf is in its upper part divided into four segments, each of considerable width and sometimes of surprising length, which from the terminations preserved were commonly subdivided near their ends, sometimes merely notched, but always pointed, never lobed as in *G. huttoni.* The veins are strong, from 6 to 7 per cm., while the petiole is stout and very long, one example being fully 4 mm. wide and over 6 cm. in length, thus recalling the Oregon specimens.

There is great variation in the shape of the leaf as well as in the depth of the segmentation and the frequency of marginal dentations—from medium-sized types closely comparable with some of the deeply lobed forms included in *G. huttoni,* to large leaves of a cuneate, Plate XX, or palmate shape, Plate XXX. To one of the last named the fragmentary specimen described as *Baiera stormbergensis* certainly belongs. Plate XXI, fig. 1, 5909, appears to represent a youthful individual. In view of the great variety in the size and outline in the living *Ginkgo biloba,* too much stress cannot be placed upon such characters in dealing with these fossil representatives, and, though several authorities regard the individuals figured by Ward as examples of *G. digitata,* or at the best as varieties of *G. huttoni,* I think that the



TEXT-FIG. 17.—Outline of part of a leaf of *Ginkgoites magnifolia* (Font.), reduced five-sixths.

Molteno forms can with good reason be allotted to a new species. The name *huttoni* has accordingly been dropped, a course already followed by Walkom, though it might be noted that Ward foresaw the likelihood of having to confer specific rank on these remarkably large leaves of *Ginkgoites*, which will now be called *G. magnifolia*.

Genus BAIERA, Braun.

Baiera schencki, Feistmantel.

1889. *Baiera Schencki*, Feistmantel, Abh. k. böhm. Gesell. Wiss. Prag., p. 70, pl. iii, figs. 1, 2, 5, 6.

There is nothing to add to the original description; indeed, no better examples have since been collected. As pointed out, it is close to *B.* (*Jeanpaulia*) *münsteri*,* from the Rhaetic of Germany, *B. paucipartita* † from the Rhaetic of Sweden, and *B. bidens*, from the Ipswich Beds of Queensland.

GINKGOALES ?

Genus STACHYOPITYS, Schenck.

1903. *Stachyopitys* sp. Seward, Ann. S. Afr. Mus., vol. iv, pt. 1, p. 66, pl. ix, figs. 2, 2*a*.

Nothing can be added to Seward's discussion of the position of this fossil.

E.—CYCADOPHYTES.

BENNETTITALES.

Genus ZAMITES, Brongniart.

Zamites *cf.* rajmahalensis (Morris).

Text-figure 18, A.

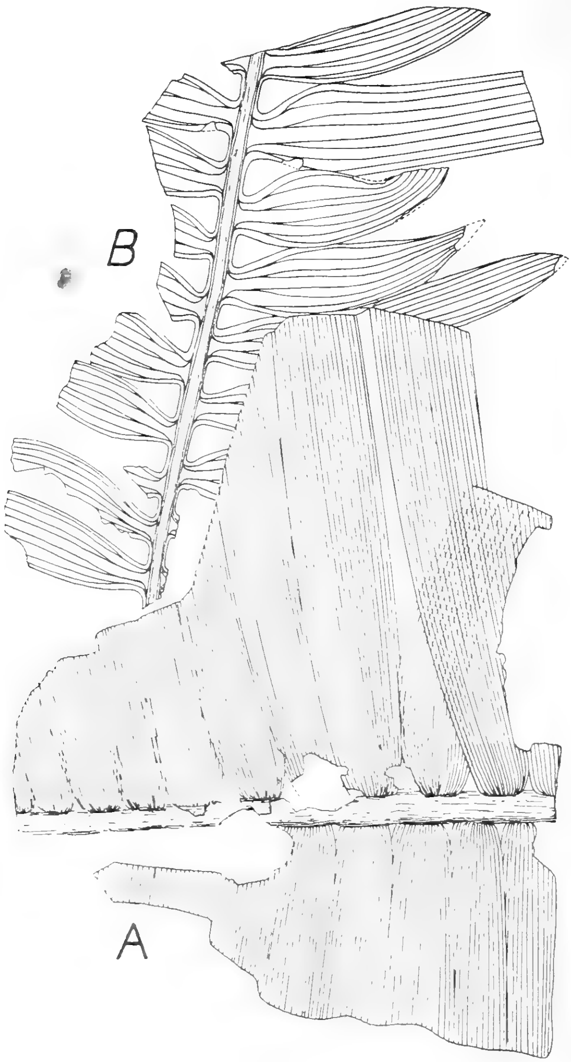
1863. *Pterophyllum* (*Podozamites*) *rajmahalense*, var. *latum*, Oldham and Morris (pars), Palaeont. Indica., Gondwana Flora, vol. i, p. 25, pl. xviii, fig. 2.

From Maclear comes the interesting though very incomplete specimen, 8659, that belongs to this cycadean genus, which unfor-

* Schimper, 1869, vol. i, p. 683, pl. xliv, fig. 9; Schenck, 1867, p. 39, pl. ix.

† Nathorst, 1878, p. 94, pl. xx, figs. 7–13; pl. xxi; pl. xxii, figs. 1, 2.

tunately shows the effect of crushing, in that the right-hand side has been squeezed downwards and the left raised somewhat.



TEXT-FIG. 18.—A, *Zamites* cf. *rajmahalensis* (Morr.); B, *Pseudoctenis lanciformis*, sp. nov.

The rachis is represented by a cast 7 mm. in breadth showing longitudinal striations, and the segments are attached towards its upper margin, and appear to overlap the rachis slightly, a character

reckoned by Seward as of generic importance. The segments must have been long, probably well over 15 cm. in length, are arranged very nearly at right angles to the rachis, are alternate, and are set close together, while, owing to their rapid increase in breadth initially, their contiguous sides come to overlap within a short distance from their bases. The latter are straight or nearly so, and there is an indication of a basal callosity. The veins, about 18 in number, are strong and parallel, though at the very base, as indicated in the drawing, they curve somewhat, and occasionally bifurcate. Towards their apices, as proved by some fragments belonging to the self-same frond, the veins are a little closer set, and become progressively fewer as each outer pair in turn run out very obliquely into the margins of the segment. The apices would appear to have been pointed.

The fossil appears to be very close to a form from the Rajmahal Hills, figured by Morris under the name of *Pterophyllum rajmahalense* var. *latum*, though he was undecided about the identification. There can be no doubt from the description and the drawing that this Indian plant should have been put under *Zamites*; in renaming it the term *latum* can conveniently be dropped. Owing partly to our ignorance concerning the length and termination of the segments in both the Indian and the Maclear specimens, very close comparison with other known species can hardly be instituted. It is rather like *Z. powelli*, Font., from the Triassic of New Mexico,* the segments of which are, however, bluntly ending and are set wider apart, while similar features characterise *Z. truncatus*, Zeill., from the Tonkin region.† It can also be compared with *Z. recta*, Tate, from the Uitenhage (Wealden) Beds,‡ which is smaller, while the veins are more divergent at the base of the segments and radiate out to the margins much closer to the rachis.

The genus *Zamites* is present in the Bunter and Keuper, but is more abundant in the Jurassic and Cretaceous, though none of the available descriptions seem to fit this example, which is the only representative so far discovered in the Molteno Beds. Provisionally it can be regarded as *Z.* cf. *rajmahalensis* (Morris); (see also p. 405).

* Fontaine, 1890, p. 285, figs. 5–7.

† Zeiller, 1903, p. 166, pl. xliii, figs. 3–6.

‡ Seward, 1903, pl. iii, figs. 1–3, 8–12; pl. vi.

BENNETTITALES.

Genus PTEROPHYLLUM, Brongniart.

But few of the cycadean remains from the Molteno Beds are referable to this genus, since a number of forms supposedly generically identical differ in several important respects, and must now be placed under *Pseudoctenis*. The genus *Pterophyllum* was apparently not a common one in South Africa at this period.

Pterophyllum multilineatum, Shirley.

Plate XXII, fig. 2.

1898. *Pterophyllum multilineatum*, Shirley, Proc. Roy. Soc. Queensl., vol. xii, p. 91, t. 7A; Queensl. Geol. Surv., Bull. 7, p. 16, t. 22.

1898. *Pterophyllum yerongense*, Shirley, Proc. Roy. Soc. Queensl., vol. xii, p. 91, t. 22; Queensl. Geol. Surv., Bull. 7, p. 16.

1903. *Pterophyllum* (*multilineatum*) Zeiller, Flore foss. Tonkin, p. 301, pl. lxvi, fig. 5.

1917. *Pterophyllum multilineatum*, Walkom, Queensl. Geol. Surv., Publ. 259, pt. i, p. 17, pl. 6, figs. 1, 2.

Some fragments of this form are represented in a collection from Konings Kroon, Elliot, the largest of which, 5901, 12 cm. in length, has been figured. The rachis is stout, from 2 to 3 mm. broad, and striated. The segments are attached at right angles thereto, are alternate to sub-opposite, from 10 to 13 mm. in breadth, nearly parallel, but slightly expanded at their roots, so that adjacent pinnae are thereby almost united. The terminations, of which only a few are preserved, are rounded or almost abruptly truncated, and are from 2·5 to 3·5 cm. in length. The veins are very fine, set closely together, are parallel, and bifurcate regularly a few millimetres after leaving the rachis, there being from 28 to 32 veins in the mid-section of a segment.

The form is indistinguishable from that first described by Shirley, and again recently by Walkom from the Ipswich Beds of Queensland, and by Zeiller from Southern China to the north of Yun-Nan. In the figure given in his Atlas no specific name was bestowed, but in the accompanying description Zeiller pointed out the agreement with the Queensland form, and identified it with the latter, at the same time

noting the resemblance to *P. longifolium*, Brong., from the Keuper of Europe. Other allied species are *P. rajmahalense*, Morris, from the Rajmahal Beds of India, a form with segments set a little closer together, and with veins only occasionally and irregularly bifurcating, *P. propinquum*, Göpp., from the Rhaetic of Franconia, in which the veins are, however, simple, and *P. tietzei*, Schenck, from the Rhaetic of Persia and of Tonkin, to be referred to below.

Pterophyllum *cf.* braunianum, Göppert.

Text-figure 19, A.

1844. *Pterophyllum braunianum*, Göppert, Jahresb. d. schles. Gesellsch. für 1843, p. 134.
1867. *Pterophyllum braunianum*, Schenck, Foss. Flora d. Grenzsch. p. 164, pl. xxxviii.
1887. *Pterophyllum braunianum*, Schenck, Foss. Pflanz. Albourskette, pl. v, figs. 24, 26 ; pl. vi, fig. 33.

A fairly complete curving frond, 11 cm. in length, can be compared with this European species. The laterally attached segments are from 2 to 5 mm. wide and from 9 to 12 mm. long, set nearly at right angles to the moderately broad rachis, but inclined progressively more forward towards the apex of the frond. They are contiguous near the base, slightly wider there, and decurrent, opposite to sub-opposite, parallel sided, and rounded or lanciform at the tip. The veins, which are not very distinct, bifurcate occasionally, and are from 4 to 8 in number.

There are but few species very close to this form, the nearest being *P. braunianum* from the Rhaetic of Franconia. *P. aequale*, Brong., from the Rhaetic of Scania and Tonkin, is somewhat larger and has a greater number of veins.

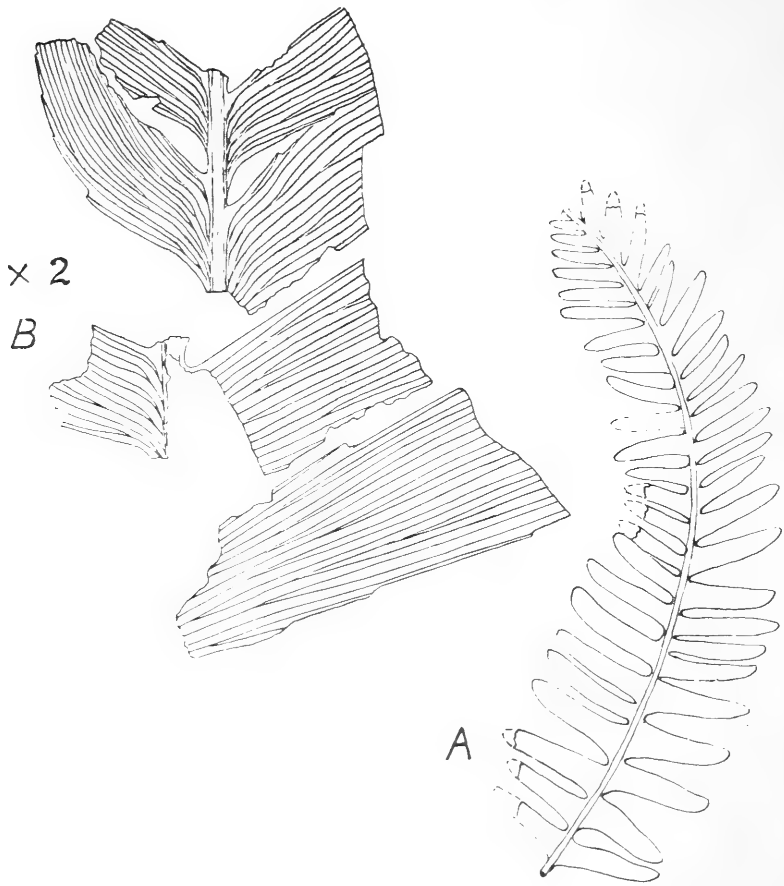
The specimen, 8322, is preserved in dark shale overlying the Indwe Sandstone on Duart Castle, Hlatimbe Valley, Natal.

Pterophyllum *cf.* braunianum, Göppert.

Text-figure 8, D.

The small fragment, 5917, text-fig. 8, D, of a curving frond figured here is also comparable with this species. The rachis is strong, but the substance has disappeared, leaving a cast of the under surface. The segments are attached at the upper edges of the rachis, are widest

at their base, and just sufficiently decurrent as to unite, are tapering, and in the smaller individuals are pointed, such being marked at the distal end of the frond. The width at the base, which is some-



TEXT-FIG. 19.—A, *Pterophyllum* cf. *braunianum*, Göpp.; B, *Moltenia* sp., ×2.

what variable, is from 2·5 to 5 mm. Of the veins, which are from 4 to 6 in number, the two outer ones, starting from the angles of the base, at first converge, become parallel, and ultimately run out into the margins of the segment before reaching the apex; the others emerge at right angles to the rachis and frequently fork, either just upon doing so or shortly after leaving the latter.

Though departing slightly from the typical habit of *Pterophyllum*,

it certainly comes close enough to the Rhaetic *P. braunianum* to be compared with that species, though the segments of the Molteno form are relatively a little broader at their base. Another comparable form is *P. nathorsti*, Seward,* from the Jurassic of Sutherland, but the veins in the latter are simpler.

Locality.—Konings Kroon, Elliot. Two other examples from the same place are 5942 and 8255.

Sub-Genus ANOMOZAMITES, Schimper.

Pterophyllum (anomozamites) inconstans (Braun).

Plate XXIV, fig. 1.

1843. *Pterozamites inconstans*, Braun, Münster's Beitr., vol. vi, p. 30.

1843. *Ctenis inconstans*, Braun, Münster's Beitr., vol. vi, pp. 41, 100, pl. xi, figs. 6, 7.

1844. *Pterophyllum inconstans*, Göppert, Ueber. d. foss. Cycadeen, p. 54; Schenck, Foss. Flora Grenzsch., p. 171, pl. xxxvii, figs. 5–10.

1870. *Anomozamites inconstans*, Schimper, Traité Palé. Végét., vol. ii, p. 140 (pars.).

1882. *Anomozamites inconstans*, Zeiller, Ann. des Mines, vol. ii, p. 318, pl. xi, figs. 4–7.

1903. *Pterophyllum* (*Anomozamites*) *inconstans*, Zeiller, Flore foss. Tonkin, p. 177, pl. xliii, fig. 8; pl. xliv, figs. 1–5.

The small piece of frond, 8325, from the Molteno Beds at the Waterfall, Upper Umkomaas Valley, Natal, can be placed in Schimper's sub-genus *Anomozamites*, and referred to the species *A. inconstans* from the Rhaetic of Germany, the distinguishing characters being the short, opposite, nearly rectangular segments, their unequal breadth and confluent bases, with the veins emerging more or less at right angles to the rachis, and generally forking just after leaving the latter. Comparison can be instituted with Schenck's examples, especially his fig. 8, from the Lettenkohle, but Zeiller's specimens from Tonkin and China are somewhat larger.

This is a well-defined species, differing from the other well-known ones of Europe and Tonkin, such as *A. gracilis*, *A. minor*, *A. marginatus*, and *A. schencki*, though having some resemblance with *A. nilssoni*

* Seward, 1911, p. 694, pls. iv, v.

(Phill.) from the Jurassic of Yorkshire,* and is also known from the Mesozoic of Tasmania.†

BENNETTITALES ?

Genus MOLTENIA, gen. nov.

"Frond linear, broad; rachis stout, bearing linear segments at right angles, opposite to sub-opposite, widely spaced; segments tapering slightly, bluntly terminating, slightly contracted towards base, strongly decurrent and confluent; venation like that in *Pseudoctenis*, with four veins forking on leaving the rachis and bifurcating again later; margins of segments having a number of dentations, with one and perhaps both of a pair of veins terminating in a tooth."

Moltenia dentata, gen. et sp. nov.

Text-figure 20.

In the shales from the Waterfall, Upper Umkomaas Valley, Natal, there is represented a very peculiar form, 8655, which, though agreeing in a number of respects with *Pseudoctenis*, Seward, has been placed in a new genus; its exact position is uncertain, and will have to await the acquisition of further material.

As indicated in the drawing, text-fig. 20, there are borne on a stout woody rachis, 3 mm. wide, gently curving segments 7 cm. in length, opposite to sub-opposite, slightly constricted towards the base, and attaining their greatest width of about 1 cm. a short distance away from the rachis. The lower edge is strongly decurrent, and by means of the alate margin to the rachis it becomes confluent with the upper curving edge of the adjoining segment. The spacing is wide, the intervals being from 6 to 8 mm.

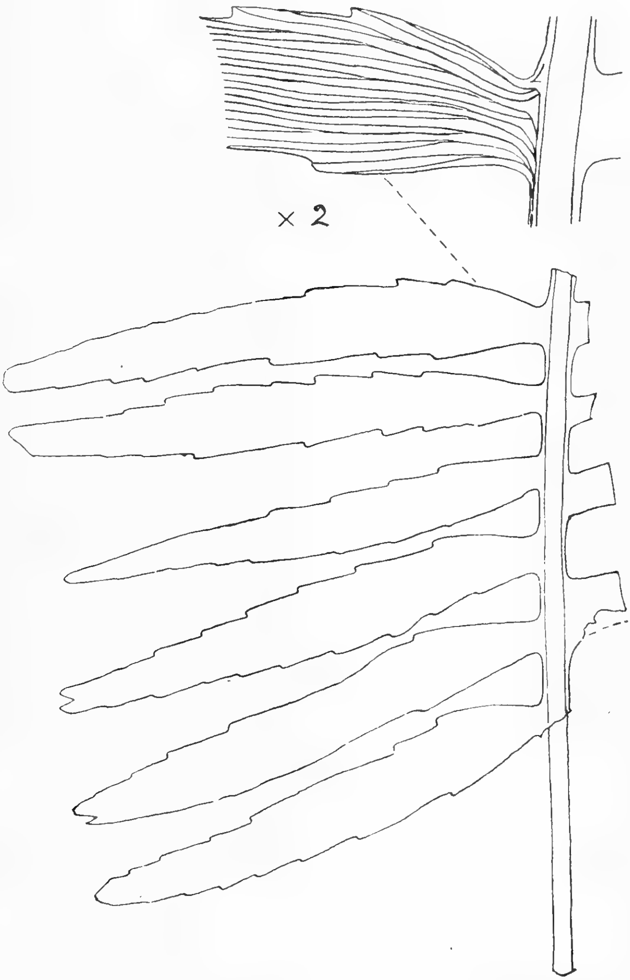
The venation is like that in *Pseudoctenis*—that is to say, the veins, four in number, emerge at oblique angles and then curve outwards, bifurcating in doing so, and forking again later; that in the upper edge curves downwards slightly.

The important character of the form is the dentate margin in the segments, which distinguishes it from almost all described genera. For a distance of about 1·5 cm. from the rachis the margin is smooth,

* Seward, 1900, p. 204, fig. 36; 1917, p. 558, fig. 615.

† Walkom, 1925*a*, p. 66.

but from thence to the apex there are from 7 to 8 small dentations, each bringing about a reduction in the width of the lamina. On



TEXT-FIG. 20.—*Moltenia dentata,* gen et sp. nov., with enlargement to show the venation.

forking, the one branch of the vein runs out midway in each smooth section, while the other ends in the point of the dentation just beyond, and this character holds regularly almost to the apex of the segment. The pinnae are firmly attached to the rachis, and may not have been sessile, while the lamina is thick and the veins strongly marked.

Unfortunately, cuticular preparations were not possible, and the epidermal structure could not be made out.

In considering the affinities of this plant the living cycadean genus *Encephalartos* of South Africa is decidedly recalled, particularly the species *E. altensteinii*, Lehmann, in which the segments have conspicuously spinous borders with one of the divergent veins extending into each process, while other points of resemblance are the manner of attachment, the contraction at the base of the segment, the venation in that quarter and the thick texture of the pinna. Comparisons can also be instituted with *Dioon spinulosum*, Dyer, of Mexico, in which the veins are, however, unbranched. Through the kind offices of Dr. R. H. Compton, Director of the National Botanic Gardens, Kirstenbosch, Cape Town, and the kindness of Professor C. J. Chamberlain of the University of Chicago, I was able to study pinnae of *D. spinulosum* and *D. edule* from Mexico, and the resemblances with *Moltenia* are certainly strong. The veins, for example, show the same convergence from both upper and lower corners of the segment with an occasional bifurcation just on emerging from the rachis. In the second of these species the margins are smooth as in *Pseudoctenis*, but in the first-named there are short spines, fewer on the lower edge of the segment, and into each one in succession runs a vein ; between the last spine and the sharp apex the remaining veins, converging slightly, run out in turn to the smooth margins. As is well known, there is considerable variability in this spinous character in both *Dioon* and *Encephalartos*, a feature due to age or to other causes ; in *E. altensteinii*, for example, pinnae with smooth outlines are sometimes associated with spinous ones on the same plant. Attention might also be drawn to the specimen shown in text-fig. 19, B, in which the venation is even more like that of *Encephalartos* than in the form under description.

Among fossil representatives is Newberry's *Encephalartos* (*?*) *denticulatus* * from Rhaetic Beds in Honduras in which the segments, set at almost 45 degrees to the rachis, are shorter and broader, while the fine nerves are more radiate and terminate in the spinose teeth of the margins ; the method of attachment is more like that in *Zamites*. In *Encephalartos cretaceus*, Knowl. ex Lesq. MS.,† from the Dakota Beds the leaf is much larger, while the nature of the base and means of attachment are unknown. Fontaine's *Encephalartopsis nervosa* ‡

* Newberry, 1888, p. 342, pl. viii, fig. 5 ; Seward, 1917, p. 507.

† Lesquereux, 1891, p. 29, pl. i, fig. 12.

‡ Fontaine, 1889, p. 174, pl. lxx, fig. 4 ; pl. lxxi, figs. 3, 4, etc.

from the Potomac Beds is more like the Molteno plant, but its segments are oblique to the rachis and the veins are sub-parallel with cross-connections, the latter character suggestive of the genus *Ctenis.*

The absence of anastomoses would under the circumstances bring the form much nearer to the fossil genus *Pseudoctenis,* more particularly by reason of the decurrent nature of the segments and the character of the venation, but, since the various species of this genus all possess smooth margins, it would be preferable not to place the plant in question under that generic name. On the other hand, while the resemblances to *Encephalartos* are uncommonly strong, it would be unsatisfactory without further knowledge to presume generic identity of the Molteno plant and a living form, wherefore the new genus *Moltenia* has been instituted.

In the absence of any evidence as to the epidermal structure owing to the nature of the preservation, it is considered that the Natal fossil has its closest affinities with the *Zamiae,* and consequently should be placed in the class of the Bennettitales.

Moltenia, sp.

Text-figure 19, B.

The scraps figured here, 406u, from the same locality as the last, though most fragmentary, are discussed merely because of their bearing on the nature of these cycadophyte remains. As will be observed, the segments are like those of *Pseudoctenis,* but the margins show slight dentations to which the veins after bifurcation lead. The venation is hence more like that of the living *Encephalartos altensteinii* or *Dioon spinulosum,* and differs somewhat from that in *Moltenia dentata,* in which every alternate vein terminates in a tooth. While it can be referred to that genus, it is inadvisable to bestow a specific name because of its fragmentary condition.

Attention might be directed to the fragment described by Johnston from the Mesozoic of Tasmania as *Sphenozamites feistmantelli,* doubtfully referred by Walkom to *Otozamites,** which similarly displays irregularly indented margins with a slightly radiating venation.

* Walkom, 1925, p. 88, fig. 18.

NILSSONIALES.

Genus PSEUDOCTENIS, Seward.

This genus was created by Seward for certain pinnate fronds agreeing in habit with *Ctenis*, but intermediate between that genus and *Pterophyllum* and distinguished by the almost complete absence of any cross-connections between the veins. Indeed, a number of forms known for long under the name of *Pterophyllum* have only recently been transferred to this new genus. Many of them are very like *Pterophyllum*, from which they are to be distinguished by the decurrent lower margins of the pinnae, the more or less confluent character of the bases of the latter, and the peculiar curving of the veins upon leaving the rachis.

Pseudoctenis *cf.* balli (Feistmantel).

Plate XXIII, fig. 1.

1881. *Anomozamites balli*, Feistmantel, Rec. Geol. Surv. India, vol. xiv, pt. 3, p. 256, pl. ii.
1886. *Platypterigium balli*, Feistmantel, Palaeont. Indica., Gondw. Flora, vol. iv, pt. 2, p. 37, pl. iiA, figs. 4–8 ; pl. iiiA, fig. 2.
1917. *Pseudoctenis balli*, Seward, Fossil Plants, vol. iii, p. 586.
1920. ,, ,, Seward and Sahni, Palaeont. Indica., New Ser. vii, Mem. 1, p. 14, pl. iv, fig. 41.

The frond here figured, 8315, from Duart Castle, Hlatimbe Valley, Natal, has a length of 21 cm. with the apex missing. On the stout rachis are borne segments of unequal length emerging almost at right angles and then curving forward, which feature becomes more marked towards the distal end of the frond, there being reasons for believing that the apex thereof was constituted by two diverging segments. The segments are decurrent, each just uniting with the upper angle of the pinna below ; their sides are parallel until near the termination, when the lower edge turns up and the segment becomes truncate. At the base of the frond the several stages in the evolution of the segments is particularly well seen, from an alate development on the rachis to the mature pinna. The rachis is stout, striated longitudinally, and in the distal region may perhaps have been covered by the lamina. The strong veins curve out from the rachis, 4 to 5 in number, giving rise to from 8 to 10 and forking again farther out.

The unequal breadth of the segments and their abnormal character at the base of the frond would alone serve to distinguish this form from *Pterophyllum.* Although the Indian plant called by Feistmantel *Platypterigium* has its lower half missing and comes from the Barakar Stage, a geological division of the Gondwanas much lower than the Molteno Beds, yet the resemblances with the Natal form are indeed considerable. The other Indian species of *Pseudoctenis* obtained from Jurassic strata differ in important particulars, as does *P. eathiensis* (Richards) described by Walkom * from the Ipswich Series of Queensland, but, excepting as to the size of the segments, there are marked resemblances with *Ctenophyllum wardii,* Fontaine,† from the Jurassic of Oregon, a form which from the figures and descriptions can, as Seward has pointed out, be referred to *Pseudoctenis.*

Another small example, K 1, 299, from the same locality, can be placed with the above.

Pseudoctenis carteriana (Oldham).

Plate XXI, fig. 2.

1863. *Pterophyllum carterianum,* Oldham and Morris, Palaeont. Indica., Gondw. Flora, vol. i, pt. 1, p. 22, pl. xv, fig. 4; pl. xvii, fig. 1.

1877. *Pterophyllum carterianum,* Feistmantel, Palaeont. Indica., Gondw. Flora, vol. i, pt. 3, p. 176, pl. iii, fig. 3; pl. v, fig. 2.

1908. *Pterophyllum* sp. Seward, Quart. Journ. Geol. Soc., vol lxiv, p. 104, pl. ii, fig. 6.

Oldham, and after him Feistmantel, described certain fronds from the Rajmahal Hills, which, however, differ from *Pterophyllum* in the particular generic characters noted above, the form having subsequently been placed by Seward under *Pseudoctenis.*

The example, 8266, from the Waterfall, Upper Umkomaas Valley, Natal, though fragmentary, is very like the Indian specimens, as indicated by the decurrent lower margins and confluent bases of the segments; they are further unequal in breadth and have their apices truncate. Excepting in the case of the outer ones of each segment, the veins are given off almost at right angles and are either undivided

* Walkom, 1917*a*, p. 19, pl. vii, figs. 1 and 2.

† Fontaine, 1900, p. 357, pls. lix, lx, and lxvii, fig. 5; Ward, 1905, p. 107, pl. xxiii, figs. 5–12.

or fork at or just after leaving the rachis; they are about 16 per cm. or 0·6 mm. apart.

Seward * regards as probably identical with *Pseudoctenis carteriana* the species described under *Ps. eathiensis* from the Jurassic of Graham Land by Halle,† which is much larger than our specimen, with veins running parallel and set further apart in the widely spaced segments. Halle has furthermore pointed out its resemblances to *Pterophyllum morrissianum*, Oldham, which Seward on the contrary considers to be a *Nilssonia*.

2. The apical portion of the frond figured by Seward in 1908 from Konings Kroon, Elliot, pl. ii, fig. 6, as *Pterophyllum* sp., is identical with the Natal example and can conveniently be ascribed to *Ps. carteriana*. There can also be cited the fragment from the Ipswich Bedsd escribed by Etheridge Jr.‡ as *Pterophyllum* sp., and compared by him with *P. carterianum*; from the description it is a *Pseudoctenis*, and rather like the Natal one, though Walkom § has referred it to *Ps. eathiensis*.

3. Another length of frond, 8267, from the Waterfall, Upper Umkomaas Valley, Natal, is like that described above and can also be allotted to *P. carteriana*, but smaller, although the length preserved is 15 cm. The segments with rounded apices are generally about 20 mm. long by 5 mm. wide, markedly decurrent and confluent at their base with a venation of just the same character.

Pseudoctenis fissa, sp. nov.

Plate XXII, fig. 3.

This remarkable specimen, 8669, from the Molteno Beds of Duart Castle, Hlatimbe Valley, Natal, is almost unique, and it is hence regrettable that so little of the frond has been preserved, though that it is not an aberrant form is suggested by the existence of a second fragment, 8312, from the same locality. On the stout rachis are borne short, sub-opposite segments, widely spaced though confluent at their base, with a strong venation precisely like that recorded for *Pseudoctenis* cf. *balli*. The outstanding feature, however, is the manner in which the segments terminate, for their apices, while sometimes rounded, may be deeply cleft, several degrees in the depth of

* Seward, 1917, p. 586.

† Halle, 1913, p. 51, pl. 6, fig. 8.

‡ Etheridge, 1892, p. 384, pl. 16, fig. 3.

§ Walkom, 1917, p. 20.

such indentations being shown in the figure, which has purposely been drawn to an enlarged scale.

A faintly indented apex is present in a few of the segments of the example of *Anomozamites nilssoni* figured by Seward,* but the species in question is wholly unlike that form and is moreover an undoubted *Pseudoctenis*. Feistmantel † has described as *Pterophyllum fissum* some small fronds from the Rajmahal Beds, which display this uncommon forked character in the majority of the segments. These Indian forms are a little smaller than the Natal one, the segments much closer spaced and decidedly oblique to the rachis, but, unlike a true *Pterophyllum,* they are confluent at the base, while the veins, emerging obliquely from the rachis, run straight and parallel for some little distance before bifurcating, features that have led Seward and Sahni ‡ to remove the plant to the genus *Nilssonia* and to redescribe it as *N. fissa* (Feist.).

The remarkable forked character of the Natal fossil, which is in other respects closely allied to *Pseudoctenis* cf. *balli*, renders it necessary to make the specimen, fragmentary though it be, the type of a new species of *Pseudoctenis,* which can appropriately be named *P. fissa.*

Pseudoctenis lanciformis, sp. nov.

Text-figure 18, B.

This form from the town of Maclear, 8659, differs in several respects from the other species described here. The segments, which are attached laterally, are much constricted at the base, where they are not more than 5 mm. wide, decurrent and almost confluent owing to a narrow alate edge to the rachis, just as in *Moltenia*, expanding into an elongated lanciform pinna. The segments are set nearly at right angles, but curve forward near their apices, particularly in the distal end of the frond ; an appreciable variability in size of the segments seems indicated from the few pinnae preserved.

The venation is peculiar. Only two veins leave the rachis, one at either corner of the segment ; they curve sharply outwards and converge, bifurcate, and each of these in turn forks within a distance of 1 cm. from the rachis, so that the segment comes to be traversed by 8 nearly parallel veins, which upon nearing the apex converge slightly.

Such characters are sufficient to distinguish this form from all

* Seward, 1900, fig. 36.

† Feistmantel, 1877, p. 61, pl. xxxix, figs. 2, 2*a*, 3, 4.

‡ Seward and Sahni, 1920, p. 32, pl. iv, fig. 39.

other species of *Pseudoctenis* that can be referred to, and a new specific name is hence unavoidable.

Pseudoctenis spatulata, sp. nov.

Plate XXIII, figs. 2 and 3; Plate XXIV, fig. 2; Text-figure 21.

This peculiar form is represented by several specimens excellently preserved in a flinty rock, which together serve to display the essential characters of the frond. This must have been large, over 30 cm. in length, with stout striated rachis, well developed right up to the apex.

As shown in specimen 6194, Plate XXIV, fig. 2, the laterally attached segments emerge very nearly at right angles, but sometimes tend to curve backwards slightly. Towards the base of the frond they are spatulate, with marked constriction near the rachis, but distally, as shown in Plate XXIII, fig. 2, they become shorter, almost lobiform, and conspicuously convex. In mid-frond the segments are long, clearly exceeding 5 cm., and are over a centimetre broad, but the terminations are regrettably not preserved, though it can scarcely be doubted that they would also be spatulate. Detached segments would hence resemble certain small leaves of *Cordaites*. They are opposite to sub-opposite, and widely spaced, but the expansion away from the rachis brings the edges of adjacent segments closely together, so as even to overlap; the lower edge is decurrent. A striking feature is the lobiform character of the apical pinnae. The veins are particularly strong, from 7 to 10 in number, and pass out obliquely in the lower half of the base, but are nearly at right angles to the rachis in the upper half, to bifurcate almost immediately or shortly thereafter, Plate XXIV, fig. 2, and so produce from 24 to 28 veins in the mid-segment.

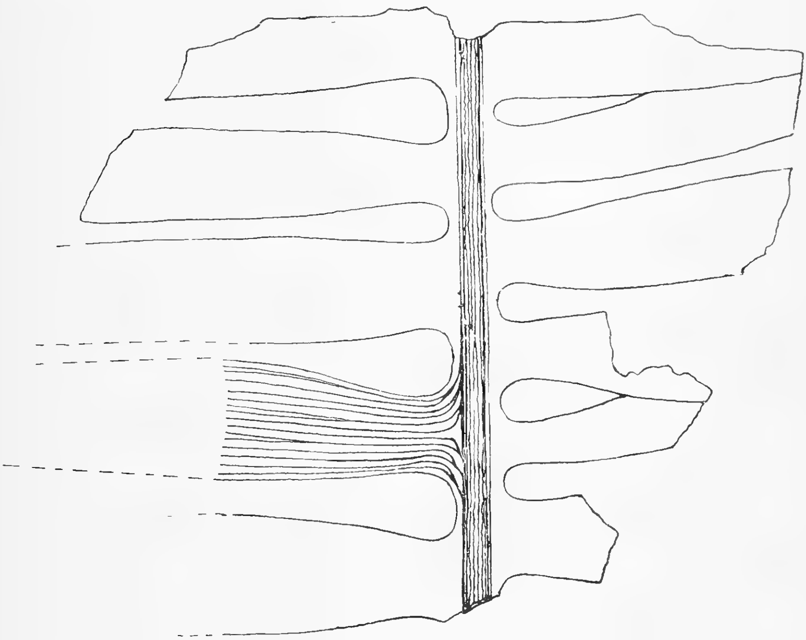
Though there are several described species of *Pseudoctenis* in which the larger segments display marked resemblances to the form under description, the lobiform character of the distal segments is one that does not appear to have been recorded, and the Molteno plant must be recognised as a new species. In *Pseudoctenis* (*Ctenophyllum*) *pachynerve* (Fontaine), from the Jurassic strata of Oregon,* this spatulate character is present, the veins are conspicuously developed, and the venation is the same. From a comparison of the basal portions alone of the two forms there would have been little hesitation in announcing their close relationship, if not specific identity, but the

* Ward, 1905, p. 106, pl. xxiii, figs. 1–4.

apices are wholly different, the distal segments in the American form being large and falcate.

The specimens figured come from Konings Kroon, Elliot; other examples from the same band of rock are 6208, 6619, 6624, 8246.

The fragment of the same form, 8257, that is reproduced in text-fig. 21, also from this locality, is evidently from a larger frond, but has the more widely spaced segments nevertheless confluent at their



TEXT-FIG. 21.—*Pseudoctenis spatulata*, sp. nov.

bases; none of the terminations have been preserved. Conspicuous is the unequal widths of the segments, when measured at their minimum breadths, close to the rachis, a feature marked also in the type, Plate XXIV, and recalling such a character in *Pterophyllum inequale*, Fontaine,* which ought to be placed under *Pseudoctenis*. This particular plant from the Trias of Virginia shows truncated segments, decurrent at their bases, and possessing an identical venation, excepting that the veins after bifurcating are simple right up to the end of the segment, whereas invariably in the South African form certain of them fork again.

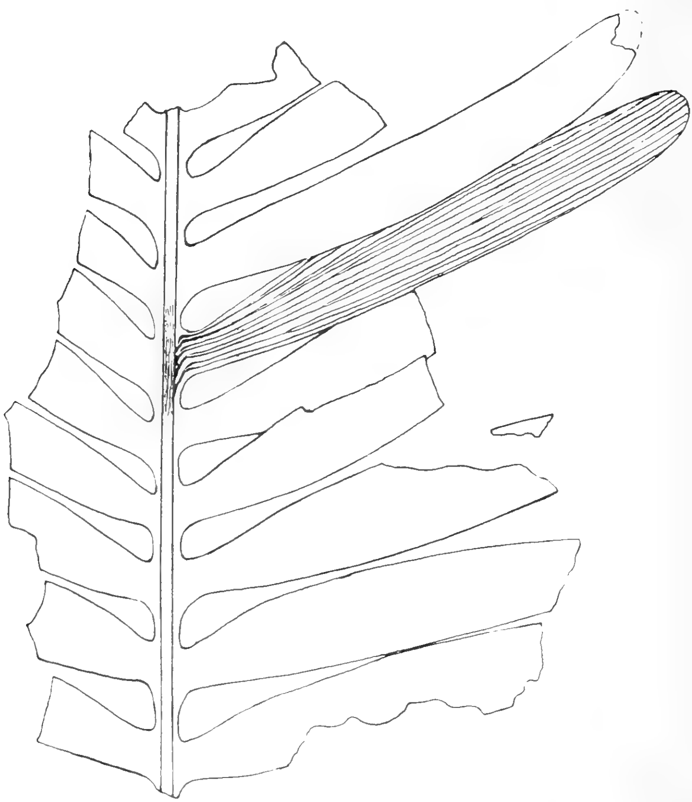
* Fontaine, 1883, p. 64, pl. xxxvi.

PSEUDOCTENIS CAPENSIS, sp. nov.

Text-figure 22.

1904. *Pterophyllum* sp. cf. *footeanum*, Seward, Second Rep. Geol. Surv. Natal, p. 102, pl. v, fig. 9, 9*a*.

The portion of the frond, 8256, figured from the Molteno Beds of Konings Kroon, Elliot, belongs to a form with segments up to 1 cm.



TEXT-FIG. 22.—*Pseudoctenis capensis*, sp. nov.

in width set at an angle of about 75 degrees to the stout rachis; they are laterally attached and do not overlap the latter, are contracted near the base, decurrent and confluent. The longer of the two complete segments is 7·5 cm. in length, and has a spatulate termination.

The veins are very strong, from 4 to 5 in number where they emerge

very obliquely from the rachis, thereupon forking and curving, while the course taken by the pair running next the upper edge of the segment makes a sharp inflection before they proceed through the lamina. Some further forking takes place within the segment, so as to produce altogether from 10 to 12 parallel veins; no cross connections are to be observed.

This form is identical with the example from the Loteni (Upper Umkomaas) Valley, Natal, figured by Seward as *Pterophyllum* sp. cf. *footeanum*, Feist., and must be regarded as the same plant. These two specimens, however, can hardly be *Pseudoctenis* (*Pterophyllum*) *footeana*,* known from the Rajmahal Beds of India, for in the latter form the veins that traverse the segments—which are furthermore somewhat closer spaced and more obliquely set—are only 6 or 8 in number, while only occasionally is forking to be seen, such as is the rule in the South African plant. The smaller number of veins helps to distinguish it from *P. spatulata*. The form is rather like the species *P. lanei* described by Thomas † from the Jurassic of Yorkshire, and was provisionally identified therewith, but in correspondence Dr. Thomas stated that none of his examples displayed the peculiar kinks nor the forking shown by the veins in the Natal plant on leaving the rachis.

For these, as well as for several other reasons, it has been thought better to establish a new species.

F.—CONIFERALES.

Genus CONITES, Sternberg.

Conites charpentieri, Zeiller.

Plate XXIV, fig. 3.

1903. *Conites charpentieri*, Zeiller, Flore foss. Tonkin, p. 213, pl. i, figs. 9, 13, 14.

Under this non-committal generic designation can be placed a number of small cones, 487–494q, all obtained from one thin band in the Molteno Beds at the drift on the Luzi River, Mount Fletcher. They are preserved in a hard, very fine-grained sandstone, and a certain amount of disintegration has occurred with spreading of the

* Feistmantel, 1879, p. 209, pl. vi; Seward and Sahni, 1920, p. 33, pl. iv, fig. 40.

† Thomas, 1913, p. 242, pl. xxiv, fig. 4; pl. xxvi.

thin cone-scales, but in the best of the examples the cones are from 5 to 6 mm. wide, and up to 4 cm. in length; none of them are in attachment. The scales are arranged spirally, and are generally hexagonal in outline in the exposed ends, which are about 2 mm. across, usually wrinkled, and occasionally showing pyramidal protuberances, just as has been recorded by Zeiller in the case of the Tonkin species *C. charpentieri*, with which the Molteno examples can be identified.

As he remarks, they also strongly resemble Heer's *Kaidacarpum sibiricum* * from the Jurassic of Siberia, and also, it might be pointed out, Nathorst's *K. suecicum* † from the Rhaetic of Sweden. Zeiller has fully discussed the characters and relationships of the Tonkin cones, and concludes that the form is probably gymnospermous, with affinities more with the cycads than the conifers; to his account there is nothing more to add.

Genus ELATOCLADUS, Halle.

Elatocladus sp.

Plate XXIII, fig. 4.

From near Fletcherville, East Griqualand, embedded in a flinty rock, several specimens have been obtained of woody shoots bearing numerous, spirally attached, needle-like leaves, which stand out at right angles from the stem, and then curve forward as shown by 8333, Plate XXIII, fig. 4. The shoots terminate in blunt ends, which give rise to a diverging group of forwardly directed leaves, just as in examples of *Pityites*. The larger stems bear relatively few leaves or leaf scars, the foliage being most abundant towards their apices. The leaves are about 1 mm. broad, were not improbably oval in cross-section, have a slightly enlarged base, though not decurrent, and end in a point. They are very finely striated, but do not show a medial vein.

For such coniferous branches without cones the non-committal generic title *Elatocladus* is now employed, but it is questionable whether it is worth bestowing a specific designation on such indefinite material. The shoots certainly resemble the form described by Schenck as *Palissya braunii*, Endl.,‡ from the Rhaetic of Germany, which genus

* Heer, 1880, p. 84, pl. xv, figs. 10–16; *Nachträge*, p. 29, pl. i, fig. 4*b*; pl. ix, 6*a*, 6*c*.
† Nathorst, 1878*a*, p. 52, pl. ii, figs. 14, 14*a*.
‡ Schenck, 1867, p. 165, pl. xli, figs. 2–14.

has now been split into several, but is practically indistinguishable from *Abietites densifolia*, Thomas,* from the Jurassic of Russia. The use of the name *Abietites* for material of this kind from beds not younger than Rhaetic is scarcely desirable, and hence the Molteno forms are referred to as *Elatocladus* sp., though they would seem to be closely related to the Russian plant.

Genus VOLTZIA, Brongniart.

Voltzia *cf.* liebeana, Geinitz.

Plate XXI, fig. 3.

1880. *Voltzia liebeana*, Geinitz, Mitt. k. Min. Geol. Mus. Dresden, vol. iii, p. 26.
1899. *Voltzia liebeana*, Potonié, Lehrb. Planzpalaeont., p. 301, pl. v, fig. 302.
1919. *Voltzia liebeana*, Seward, Fossil Plants, vol. iv, p. 293, fig. 748 C.

This coniferous shoot, 5824, curious to find in the Molteno Beds, displays a woody axis, with very minute pittings, round which are disposed in spiral fashion narrow linear leaves—somewhat expanded in certain of the apical ones—which show the variability in length, etc. (dimorphism) of *Voltzia heterophylla*, Brong. While there is considerable resemblance to that species, which is common in the Bunter of Germany, as shown for example on comparison with the apical portion of the shoot figured by Schimper,† the length of the leaves and their much wider spacing render this form practically indistinguishable from *V. liebeana*, Gein., from the Upper Permian of Germany. Figures of the latter are given by Potonié and Seward. No cones or cone scales occur in association with this shoot. In certain ways, too, it recalls the form *Elatides* (*Palissya*) *sternbergii* (Nath.) ‡ from the Rhaetic of Sweden.

Voltzia has not yet been recognised from South Africa, though the genus *Voltziopsis* is recorded by Potonié from East Africa in association with *Glossopteris*, but *V. heterophylla* probably occurs in the Lower Gondwana Beds of India.

* Thomas, 1911, p. 79, pl. iv, fig. 16; pl. v, figs. 1, 2.

† Schimper, 1874, pl. lxxiv, fig. 1.

‡ Nathorst, 1878–86, p. 107, pl. xxiii, figs. 8–12; xxiv; xxv, figs. 5–8; Seward, 1919, p. 270.

G.—CORDAITALES.

Genus DADOXYLON, Endlicher.

Silicified wood is exceedingly common in the Molteno Beds, usually as portions of trunks scattered on the surface, having been weathered out of sandstone layers. One instance is known in which the stem stood upright in the sandstone. Diameters of up to about two feet are frequent, the largest trunk recorded being three feet across, while at Dordrecht stems up to over 20 feet in length were observed *in situ* many years ago.

There can be no doubt that the bulk of the examples would belong to the genus *Dadoxylon*, though whether to the species *D. arberi*, Seward, has not been determined. Wood is less abundant in the Red Beds, and is occasionally present in the Cave Sandstone, but unfortunately the samples collected at Lady Grey from the latter formation, and sent for examination, have been mislaid or lost.

Dadoxylon sclerosum, Walton.

1925. *Dadoxylon sclerosum* Walton, Ann. S. Afr. Mus., vol. xxii, pt. 1, p. 13, pl. ii, figs. 7–10.

This species comes from Modder Poort, Orange Free State, from the top of the Molteno Beds or possibly higher. Walton has compared with it a specimen from the base of the Red Beds at Kromme Spruit, Herschel.

Genus RHEXOXYLON, Bancroft.

1913. Bancroft, Trans. Linn. Soc., 2nd ser., Botany, vol. 8, pt. 2.
1921. Seward and Holttum, Geol. Surv. S. Rhodesia, Bull. 8, p. 42, pl. xi, C.
1923. Walton, Phil. Trans. Roy. Soc., Ser. B, 212, p. 79, pls. v, vi.
1925. Walton, Ann. S. Afr. Mus., vol. xxii, p. 7, pl. ii, fig. 11; pl. iii, figs. 13, 14.

This remarkable genus of fossil wood was based on a stem from an unknown locality in the Cape Province, but since then quite a number of examples have been discovered, both within and without the Union, upon which three distinct species have been established.

RHEXOXYLON AFRICANUM, Bancroft.

This has been recorded from the base of the Red Beds of Lady Grey, Aliwal North district, and also from the "Somabula Beds" (Stormberg) of Southern Rhodesia.

RHEXOXYLON TETRAPTERIDOIDES, Walton.

This occurs in the Molteno Beds at Elliot, and in the Umkomazaan Valley, Ipolela district, Natal.

RHEXOXYLON PRIESTLEYI (Seward).

First described from the Beacon Sandstone of Antarctica under the name of *Antarcticoxylon*, this species has recently been identified by Walton from the Molteno Beds of Catherine's Post near Indwe, thus constituting a most important link between Antarctica and South Africa in the early Mesozoic.

RHEXOXYLON sp.

A fragment from the Uppermost Beaufort Beds of Aliwal North may possibly be referable to *R. tetrapteridoides*.

The affinities of *Rhexoxylon* have been fully discussed by Walton,* who has pointed out that it is not related, as originally thought, to the Medulloseae, but more probably to the gymnosperms, to which the *Dadoxylons* of the Southern Hemisphere belong, being possibly Cordaitalean or Araucarian. Certain peculiarities to the genus are to be found in the wood recorded as *Dadoxylon pedroi*, Zeill., from the Gondwana Beds of Brazil.

* Walton, 1925, p. 13.

VI.—*SYSTEMATIC DESCRIPTIONS—THE UPPER BEAUFORT FLORA.*

A.—EQUISETALES.

Genus EQUISETITES, Sternberg.

Equisetites spp.

Plate XXXII, fig. 2.

There are in the Brown Collection from Aliwal North a number of nodal diaphragms belonging to the genus *Equisetites*, though in the absence of associated stems they cannot be identified with any hope of certainty.

Three of them, fig. 2, belong to stems about 3 cm. in diameter, and resemble the diaphragms of *E. münsteri*, Sternb.,* from the Rhaetic of Germany, *E. rajmahalensis*, Old. and Morr.,† from the Rajmahal Beds of India, and *E. scanicus*, Sternb.,‡ from the Lower Lias of Sweden. The central parts are missing, and closer comparison cannot be instituted.

Some other diaphragms are larger and like those referred to *E. arenaceus*, Brong., from the Keuper of Stuttgardt, and figured by Schimper.§

Genus NEOCALAMITES, Halle.

Neocalamites carreri (Zeiller).

(See p. 315.)

The Brown Collection from the Uppermost Beaufort Beds of Aliwal North contains a number of impressions of stems showing the fluted exterior. The largest of these is fully 12 cm. wide, with an internodal distance of only 4 cm., and shows about 28 leaf scars each about 2 mm. in diameter.

Other finely ribbed moulds of stem-interiors display a similarly small internodal ratio, and can therefore be referred to this species, common in the Molteno Beds.

* Schenck, 1868, pl. iii, figs. 3, 7, 8.
† Oldham and Morris, 1863, pl. i, figs. 2–4.
‡ Halle, 1908, pl. 7, figs. 11–17.
§ Schimper, 1869, pl. x, figs. 5, 6, 9.

Genus SCHIZONEURA, Schimper and Mougeot.

Schizoneura sp. *a*, Seward.

1908. *Schizoneura* sp. *a*, Seward, Quart. Journ. Geol. Soc., vol. lxiv, p. 86, pl. iii, figs. 1, 2.
1915. *Schizoneura* sp. *a*, Walkom, Queensl. Geol. Surv., Publ. No. 252, p. 36, pl. 4.

Nothing further can be added to Seward's description, except that Walkom has referred an example from the Ipswich Beds of Queensland to this species. The original comes from the Uppermost Beaufort Beds of Burghersdorp.

B.—FILICALES.

MARATTIALES ?

Genus DANAEOPSIS, Feistmantel.

Danaeopsis hughesi, Feistmantel.

Plates XXV and XXVI, fig. 1.

1882. *Danaeopsis hughesi*, Feistmantel, Mem. Geol. Surv. India., Gondw. Flora, vol. iv, pt. i, p. 25, pls. iv–x, xviii, xix.
1898. *Neuropteris punctata*, Shirley, Queensl. Geol. Surv., Bull. 7, p. 20, pl. xiv, fig. 2.
1903. *Danaeopsis hughesi*, Zeiller, Flore foss. Tonkin, p. 57, pl. ix.
1908. ,, ,, Seward, Quart. Journ. Geol. Soc., vol. lxiv, p. 95, pl. vi.
1910 ,, ,, Seward, Fossil Plants, vol. ii, p. 409.
1917. ,, ,, Walkom, Queensl. Geol. Surv., Publ. No. 257, p. 24, pl. vii, fig. 3.
1920. ,, ,, Seward, Palaeont. Indica., vol. vii, Mem. 1, p. 18, pl. iii, fig. 30.

The single specimen described by Seward from the Upper Beaufort Beds of Lady Frere has been added to by some more sterile fronds and by many portions of large fronds from the uppermost strata of that division at the town of Aliwal North, as represented in the "Brown Collection," of the South African Museum, while some other examples from that locality are in addition preserved in the Albany Museum, Grahamstown.

The new material merely serves to duplicate Feistmantel's descriptions and figures of the large fronds from the Parsora Beds (Middle Gondwana) of India; indeed in a couple of specimens, which are nevertheless incomplete, a length of 45 cm. is exceeded. These remains display the strong thick rachis forking more than once, having in the lower part thereof single pinnules, which decrease in size towards the bottom of the frond, in which position they tend to become contracted at their base. Higher up, the pinnules are larger and markedly decurrent, frequently set at an acute angle, and sometimes over 5 cm. in breadth and 15 cm. in length, each with a stout mid-rib. The secondary veins diverge at angles of about 60 degrees, but the venation is usually not well seen owing to the coarse grain of the sandstone matrix. An example of a moderately sized frond is reproduced on a reduced scale in Plate XXV, while Plate XXVI, fig. 1, shows one of the detached leaves, which have a great resemblance to *Taeniopteris* pinnules.

There is nothing further to add to Seward's account, save that these remains undoubtedly belong to the species *D. hughesi*, known from the Ipswich Series of Queensland, the Parsora (Triassic) of India, and the "Rhaetic" of Tonkin and China.

THINNFELDIAE.

Genus THINNFELDIA, Ettingshausen.

(See pp. 328–336).

The three species, *T. odontopteroides, lancifolia*, and *feistmanteli*, are all represented in the Uppermost Beaufort Beds by examples coming from Aliwal North, the Kraai River Bridge, or the village of Cala, and there is no necessity for further description.

Thinnfeldia acuta, Walkom.

Text-figure 23.

(See p. 334.)

The example, 8658, from the Uppermost Beaufort Beds of Cala is of a large bifurcating frond possessing uncommonly long pinnules, some of them over 5 cm. in length, but agreeing very well with Walkom's figure and description. The venation is the same, though

only well seen in places, and being therefore indicated diagrammatically in the drawing.

TEXT-FIG. 23.—*Thinnfeldia acuta*, Walk.

HYDROPTERIDEAE.

GENUS SAGENOPTERIS, Presl.

SAGENOPTERIS sp.

Plate XXIX, fig. 3.

The small verticil, 8332, is figured here merely to show the occurrence of this interesting genus in the Uppermost Beaufort Beds, the specimen coming from the Kraai River Bridge, Aliwal North, in association with *Thinnfeldia*.

The four tiny leaves, still in attachment to the strong, striated petiole, are lanceolate in shape, but owing to the preservation being in sandstone the venation cannot be made out. While the outline of the pinnules differs from that of most young species of *Sagenopteris*, it agrees with that in *S. undulata*, to which *S. longicaulis* from the Molteno Beds stands closest, but the Swedish plant possesses a winged petiole,* so that for the present one is hardly justified in regarding the specimen as a youthful example of the Molteno species.

Genus LEPIDOPTERIS, Schimper.

Lepidopteris stuttgardiensis (Jaeger).

Plate XXVIII.

1827. *Aspidioides stuttgardiensis*, Jaeger, Pflanzversteinerungen, Stuttgart. vork, p. 52, pl. viii, fig. 1.
1869. *Lepidopteris stuttgardensis*, Schimper, Traité Palé. Végét., vol. i, p. 572, pl. xxxiv.
1909. *Lepidopteris stuttgardensis*, Gothan in Potonié, Abb. Besch. foss. Pfl., vol. vi, p. 111, figs. 1, 2.

The large frond from the Uppermost Beaufort Beds at Aliwal North, belonging to the Brown Collection, 6148, is preserved in sandstone, which fact is responsible for the loss of much of the detail. Nevertheless the peculiarities are such as to connect this plant with the form known from the Middle Keuper of Stuttgart, of which Gothan has figured a very similar example of a sterile frond.

Conspicuous is the extremely wide spacing of the pinnae, with lanciform pinnules, attached by the whole of the base, slightly curving forward—but in which the venation cannot unfortunately be made out—and the numerous inter-pinnate pinnules. The latter are more numerous in the upper part of the frond, just as is the case in Gothan's figure. Another feature of importance is the abnormally large pinnule commonly developed in the lower part of the pinna near its base. The apical pinnae are set more acutely to the main rachis. The latter, though very stout, is not markedly striated, and leaves one with the impression that its surface was scaly, as in *Lepidopteris*, while the same character extends to the rachis of the pinnae as well.

These peculiarities serve to distinguish this plant from *Callipteridium*, which also has pinnules set directly on the main rachis.

* Halle, 1910, pl. i, figs. 4–6.

A second example in this collection, also from Aliwal North, No. 91, has the pinnae smaller and closer together in the basal part of the frond, and set more obliquely in the apical part, such recalling features present in Schimper's plate (xxxiv, fig. 1). The pinnules on the main rachis are fewer than in the first specimen, and are hardly represented towards the base of the frond. The main rachis and those of the pinnae are curiously pitted throughout, and must undoubtedly have been scaly.

A form which is compared with this species has been recorded from Madagascar.*

C.—FERN-LIKE PLANTS AND PLANTS OF UNCERTAIN POSITION.

Genus TAENIOPTERIS, Brongniart.

Taeniopteris lata, Oldham.

Plate XXIX, fig. 1.

1863. *Taeniopteris lata,* Oldham and Morris, Palaeont. Indica., vol. i, pt. i, p. 41, pls. i; ii; iii, fig. 2; v.

This portion of an immense frond, 6084, of the Brown Collection, from the Uppermost Beaufort Beds of Aliwal North, is unfortunately fragmentary, but must have exceeded 18 cm. in width; the margin is only preserved at one point, and is wavy. The rachis is broad, and shows a non-striated border on each side, which, following the view of Fontaine, represents the insertion of the lateral nerves concealed by the thick epidermis investing the mid-rib, a feature shown also in Nathorst's figure of *T. gigantea,* Schenck †; it narrows considerably in the apical portion.

The strong veins are about 1 mm. apart and emerge obliquely from the rachis to bend almost immediately at right angles to the latter, but are more acutely set in the distal part of the frond. They fork near the rachis occasionally, but more usually elsewhere in the leaf.

This form can be compared with Oldham's *T. lata* from the Rajmahal Beds of India, but, on the other hand, is not very different from *T. gigantea,* Schenck, from the Rhaetic of Germany and Sweden, and *T. magnifolia,* Rogers,‡ from the Trias—Lower Keuper—of

* Zeiller, 1911, p. 230. † Nathorst, 1878, pl. ix. ‡ Described below.

Virginia, in which the forking of the veins takes place close to the rachis. The general closeness in characters of the various large fronds of this genus from the Rhaetic, Triassic, and even the Permian—such as *T. abnormis*, Gutb.—renders it hard to make identifications of such forms with any hopes of precision, and it is not improbable, as suggested by Fontaine,* that these Trias-Rhaetic species are all representatives of the same type-form, differing only in such minor features as would have been produced in regions so remote from one another as North America, Europe, India, and South Africa.

Taeniopteris magnifolia, Rogers.

Plate XXIX, fig. 2.

1883. *Macrotaeniopteris magnifolia*, Fontaine, U.S. Geol. Surv., Monogr. vi, p. 18, pl. ii, fig. 3; pl. iii, figs. 1–3; pl. iv, figs. 1–4; pl. v, figs. 1–4.

This fragment of frond, 6085, from the Brown Collection, comes from the Uppermost Beaufort Beds of Aliwal North, and must have had a breadth of at least 24 cm. The rachis is relatively narrow, and must have had a thick epidermis as in *T. magnifolia* from the Triassic of Virginia, which species it resembles more closely than either *T. lata* or *T. gigantea*. The venation is not well seen, but the secondary veins are close together, approximately 2 per mm., and appear to emerge obliquely, forking next the rachis, and proceeding thereafter almost at right angles to the mid-rib.

A second example, 6113, from the same locality is much narrower, half of the leaf being 4 cm. wide, and must have belonged to a lengthy frond for 27 cm. of it have been preserved. The margin is slightly sinuous and thickened, while there is the same concealment as in *T. lata* of the attachment of the lamina to the rachis by reason of the epidermis. The venation is distinctly seen, and the veins bifurcate at the rachis, where they are slightly oblique, after which they bend, so as to be at right angles thereto, and then run single to the margin. The venation is hence different from that in the only large species known from Australia, *T. wianamattae*, Feist. A frond from Madagascar has, however, been compared with *T. magnifolia*.†

* Fontaine, 1883, p. 22.

† Zeiller, 1911, p. 230.

Taeniopteris nilssonioides, Zeiller.

(See p. 350.)

A fragment in the Brown Collection from Aliwal North, No. 111, belongs to a pinnule, half of which is 5 cm. wide, and can be identified with Zeiller's species. It shows a coarsely pitted mid-rib, while running out at right angles to the peculiarly irregular border are the stout veins, 12 per cm., with some finer veins in between, as can be made out in some places despite the coarseness of the matrix.

Genus ODONTOPTERIS, Brongniart.

Odontopteris browni, Seward.

1908. *Odontopteris Browni*, Seward, Quart. Journ. Geol. Soc., vol. xliv, p. 97, pl. vii.

The Brown Collection contains several slabs displaying large impressions of this form, including the counterpart, 6158, of the one figured by Seward ; all come from Aliwal North. These show fronds of the same character, up to 30 cm. in length, though wanting the apex, but having the base, and thereby revealing a feature well known in the genus *Odontopteris*.

The stout rachis bears at its very base small lobiform pinnules, which higher up are replaced by compound, tongue-shaped pinnules, contracted at their root, with veins diverging at angles of about 45 degrees from the mid-rib, while there are signs of pinnatifid characters. These are succeeded by pinnatifid pinnae with lobiform margins, and by pinnae with distinct but closely-set pinnules with odontopterid outlines attached by the whole of the base. The pinnules nearer the rachis are somewhat smaller than those farther away. The rachis also bears a lobed wing due to the decurrent bases of lateral pinnules. The venation can be made out very faintly in places, and appears to be odontopterid with veins radiating out towards the margins.

As Seward has pointed out, the affinities of this form are with Permian and Carboniferous species.

Genus CALLIPTERIDIUM, Weiss.

Callipteridium africanum, sp. nov.

Plate XXVI, figs. 2, 3 ; Plate XXVII.

(See p. 359.)

In the Brown Collection from Aliwal North are several fronds and a number of detached pinnae belonging to a form very like the species described from the Molteno Beds, though commonly much larger. One example, 6106, lacking most of the lower part, is 27 cm. long, Plate XXVII, while isolated pinnae may exceed 15 cm. in length and 5 cm. in breadth. One specimen, 6147, has pinnae only 5 cm. long and 1 cm. wide, and is hence closely comparable with the type figured in Plate XXII, fig. 1.

These large forms show, however, the same type of pinnatifid pinnae with slightly lobed or dentate margins in their proximal portion, and nearly even outlines in their distal portion, the strong and straight mid-veins in each of the concrescent pinnules and the lobed confluent pinnules on the rachis between the pinnae. The distal pinnae curve forwards and are serrated, while the apical ones are closely set, lanciform, and appear to have nearly smooth borders. The pinnules, it might be noted, range in length from 2 to 3 times their width.

The matrix consists of sandstone and the venation is rarely well seen, but the primary veins in the pinnules give off the secondary ones at a fairly wide angle, which proceed nearly straight to the margin, Plate XXVI, figs. 2, 3. The venation is hence pecopterid and not odontopterid, a feature that serves to distinguish this form from the rather similar *Odontopteris* fronds with which it occurs.

There are no clear-cut characters by which this large form can be differentiated from the small ones from the Molteno Beds, and it is hence regarded as also belonging to the species *C. africanum*.

D.—GINKGOALES.

Genus GINKGOITES, Seward.

Ginkgoites magnifolia (Fontaine).

Plate XXX.

(See p. 370.)

The Brown Collection contains several large leaves from Aliwal North, that are identical in their shape and variability with those described from the Molteno Beds of Konings Kroon. One of these, 6143, with a span of 20 cm., is reproduced here, but owing to the matrix being sandstone the venation cannot so clearly be seen as in the Elliot examples.

E.—CYCADOPHYTES.

BENNETTITALES.

Genus ZAMITES, Brongniart.

Zamites *cf.* rajmahalensis (Morris).

Plate XXXI, fig. 1.

(See p. 373.)

In the Brown Collection from Aliwal North is the fine frond figured here, 6191, and its counterpart, 6120, representing a *Zamites* very similar to that described from the Molteno Beds. The segments have been somewhat twisted, so that in places they are almost on edge in the matrix, a feature rather difficult to do justice to in the drawing, which furthermore conveys the erroneous impression that they are pointed instead of being parallel sided. Actually the drawing is a composite one built up from the impressions on the two slabs.

The stout rachis is in the form of a hollow cast, and shows a longitudinal groove along its under surface. The segments are set closely, and have lengths of up to 18 cm., the few that are complete showing a rounded termination in the lower segments, and a more pointed one in the upper ones. The base of each segment is contracted, and would appear to have overlapped the upper edge of the rachis, though possibly this is in part due to the crushing of the latter. The venation can be made out with some difficulty, and is undoubtedly of the *Zamites* type, with divergent veins in the base of the segments.

While the form agrees well with that described as *Z.* cf. *rajmahalensis* from the Molteno Beds, it might be pointed out that the segments exhibit a decided variability in breadth as well as length, and that not improbably further collecting may cause this plant to be made the type of a new species.

BENNETTITALES.

Genus PTEROPHYLLUM, Brongniart.

Pterophyllum *cf.* tietzei, Schenck.

1887. *Pterophyllum tietzei*, Schenck, Foss. Pflanzen Albourskette, p. 6, pl. vi, figs. 27-29; pl. ix, fig. 52.
1903. *Pterophyllum tietzei*, Zeiller, Flore foss. Tonkin, p. 189, pl. xlvii.
1908. *Pterophyllum* cf. *tietzii*, Seward, Quart. Journ. Geol. Soc., vol. lxiv, p. 103, pl. ii, fig. 5.

This form was described by Seward from the very uppermost strata of the Upper Beaufort Beds at the Kraai River Bridge near Aliwal North, and has correctly been compared by him with this species first recorded by Schenck from Persia. The example figured under this name by Zeiller from Tonkin is of a much larger frond, which does not display the slight decurrent character and faint contraction thereafter that is seen in both the South African and Persian plants. Nathorst's figures of *P. aequale* * show fewer veins, while in *P. multilineatum* these are more numerous, the segments being also more widely spaced. In *P. jaegeri*, Brong., according to Leuthardt,† the breadth-index is larger than in the Aliwal fossil.

NILSSONIALES.

Genus NILSSONIA, Brongniart.

Nilssonia browni, sp. nov.

Plate XXXII, fig. 1.

This fine specimen, 6134, of the Brown Collection, which is only a portion of an immense frond, is of extreme interest, because it

* Nathorst, 1878–86, p. 67, pl. xv, 6–10.

† Leuthardt, 1903, p. 14, pl. v, figs. 1–3; pl. vi, figs. 1, 2; pl. x, fig. 1.

comes from the Uppermost Beaufort Beds of Aliwal North. It shows a surprisingly slender rachis from which the segments in the mid-frond emerge at right angles to curve forward slightly, while in the distal portion this curvature becomes more marked. The segments are openly spaced, slightly contracted near the base, decurrent and confluent, opposite to alternate and somewhat variable in width in different parts of the frond, generally narrower in the lower portion. The breadths range from 0·6 to 1·5 cm., and the lengths up to 13 cm. at least, the ends being bluntly pointed.

Although the preservation is in sandstone, the venation can be made out under oblique illumination. The veins are numerous and fine—about 20 per cm.—decurrent in the lower half of the segment, and at right angles in the upper one.

The general characters might lead one to place this form under *Pseudoctenis* were it not for the decisive fact that the segments, which in mid-frond are seen to be attached laterally, come in the distal portion to overlap the rachis so that the latter is completely hidden by them; the lamina must have been continuous across its surface. This character renders it clear that the genus represented is undoubtedly *Nilssonia*, remarkable when the age of the formation is considered.

In instituting comparisons it is found that there are but few species possessing the size and characters of this form. In *N. pterophylloides*, Nath., from the Rhaetic of Sweden, the segments are much narrower and the veins fewer. *N.* (*Pterophyllum*) *princeps* (Old. and Morr.), from the Rajmahal Beds of India, has much broader and shorter segments, but much closer is the species *N.* (*Pterophyllum*) *morrisianum* (Old.) * from the same strata. As Seward † has remarked, this is a *Nilssonia*, which Oldham's plate xv, fig. 1, shows, though Halle ‡ prefers to place it under *Pseudoctenis*.

The South African form differs from the Indian in the more variable width of the segments, in the presence of a contraction near their base, and in the absence of the border to which Oldham particularly refers; the venation is the same. Though the Rajmahal plant comes very near to that from Aliwal North, the differences are considered sufficiently great as to justify the latter being made the type of a new species, which is called after the late Mr. Alfred Brown of Aliwal North, the discoverer of this as well as so many other fossils.

* Oldham and Morris, 1863, p. 20, pl. xv, fig. 1; pl. xvii, fig. 2.

† Seward, 1917, p. 578.

‡ Halle, 1913, p. 52.

It might be noted that it also greatly resembles the form from the Permian of Saxony described by Geinitz as *Pterophyllum cottaeanum*,* which shows an overlapping of the segments upon the narrow channelled rachis in the distal part of the frond, making it probable that this is actually a *Nilssonia*. The long segments are 1 cm. wide, decurrent and confluent, but the venation, while like that in the South African plant, is not quite so fine. If this view be correct, the genus *Nilssonia* would be represented in the Lower Permian.

The collection contains a second example, 6095, from the same locality, representing the distal part of a frond, with segments varying in widths and curving forward in regular arcs, the lamina almost concealing the rachis.

F.—CONIFERALES.

Genus STIGMATODENDRON, Eichwald.

Stigmatodendron dubium, Seward.

1908. *Stigmatodendron dubium*, Seward, Quart. Journ. Geol. Soc., vol. lxiv, p. 100, pl. iii, fig. 3.

The Brown Collection contains the large convex stem of which the type described by Seward constitutes the greater part of the mould. The original is 35 cm. in length and 8 cm. at its widest, contracting from a swelled portion covered with large rhomboidal or sub-circular prominences to a relatively smooth conical base 3·5 cm. in length and 2·5 cm. in diameter, terminating abruptly. The beginning of this conical portion is just distinguishable at the very top of Seward's photograph, which should have been inverted.

Nothing further can be added as to the affinities of this stem, but the possibility that it might belong to the ferns should not be overlooked. The comparisons that have hitherto been made of the Aliwal North plant have been with stems from the Palaeozoic of Europe.

Genus STROBILITES, Schimper and Mougeot.

Strobilites laxus, Seward.

1908. *Strobilites laxus*, Seward, Quart. Journ. Geol. Soc., vol. lxiv, p. 101, pl. v, fig. 3, text-fig. 7.

* Geinitz, 1862, p. 146, pl. xxxiii, fig. 1.

Nothing additional can be said in respect to this strobilus, which comes from the Uppermost Beaufort Beds of Aliwal North. The comparisons are generally with Permian and Triassic types.

VII.—*THE UPPER KARROO FLORA OF SOUTHERN RHODESIA.*

In 1921 certain plants collected at Willoughby's in the Somabula area were described by A. C. Seward and R. E. Holttum * from a sandstone which would appear to represent the base of the Forest Sandstone Series, and hence of Stormberg age, though whether it is actually the equivalent of the slightly lower group known as the "Escarpment Grits" is not yet known.

In 1923 J. Walton † gave an account of the *Rhexoxylon* stems identified as such by the above two authors, and in 1927 ‡ reported on some further material from the same locality, to which the writer also briefly contributed.§ The writer also described elsewhere || some fragmentary remains from the Forest Sandstone of the Mafungabusi area farther to the north.

The list to date is as follows :— ¶

Schizoneura gondwanensis, Feist.
Taeniopteris m'cClellandi, Old. and Morr.
* ,, sp. (?) *carruthersi*, Ten.-Woods.
* *Thinnfeldia odontopteroides* (Morr.).
* ,, *lancifolia* (Morr.).
* ,, *feistmanteli*, Johnst.
Pachypteris (?).
Cf. *Pleuromeia.*
Dadoxylon sp.
* *Rhexoxylon africanum*, Bancr.
Cyparissidium cf. *nilssonianum*, Nath. (Mafungabusi).

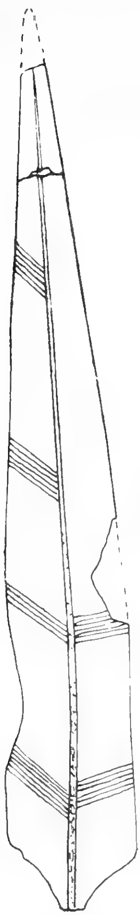
(Those marked with an asterisk are Molteno forms.)

Schizoneura gondwanensis occurs in the Raniganj Stage of India, and has been identified by the writer from the top of the Lower Beaufort group in Natal, both these formations being of Uppermost

* Seward and Holttum, 1921, pp. 39–45, pls. ix–xi.
† Walton, 1923, p. 96, pl. vi, fig. 16.
‡ *Ibid.*, 1927, pp. 137–140, pl. xvii.
§ Du Toit, 1927*a*, p. xxxi. || *Ibid.*, 1927, p. 12.
¶ *Ctenopteris* sp. is actually *Thinnfeldia feistmanteli.*

Permian age. *Taeniopteris m'cClellandi* has not been discovered elsewhere in South Africa, and characterises the Rajmahal Beds of India, but is also unquestionably represented in the Trias-Rhaetic of Argentina by a specimen, No. 7130, in the South African Museum, coming from Barreal.

This assemblage would accordingly suggest an age not later than Rhaetic for the Somabula Beds, and not improbably an Upper Triassic one.



TEXT-FIG. 24.—*Taeniopteris m'cClellandi*, Old. and Morr.; showing the course of the venation in different parts of the pinnule.

TAENIOPTERIS M'CCLELLANDI, Oldham and Morris.

Text-figure 24.

(For synonymy see Walton, Trans. Geol. Soc. S. Afr., vol. xxix, p. 138, pl. xvii, figs. 1, 2.)

In view of the very indistinct illustrations in Walton's paper a drawing is given in text-fig. 24 of a pinnule 12 cm. in length, abruptly contracted at the base, and tapering regularly to a narrow point. The veins are set at an angle of about 75 degrees in the basal part, but more acutely towards the apex. The Rhodesian examples are the only specimens of *Taeniopteris* from South Africa in which the pinnules have been found still attached to the rachis.

GENUS CYPARISSIDIUM, Heer.

CYPARISSIDIUM *cf.* NILSSONIANUM, Nathorst.

Plate XXXI, figs. 2–5.

1878–86. *Cyparissidium nilssonianum*, Nathorst, Sver. Geol. Unders., ser. C. 25, p 103, pl. xxii, figs. 12–19; 24–32.

1905. *Cyparissidium nilssonianum*, Zeiller, Bull. Geol. Soc. France, vol. v, pt. 2, p. 190.

1927. *Cyparissidium* cf. *nilssonianum*, Du Toit, S. Rhod. Geol. Surv., Short Rep., No. 20, p. 12.

The account by the writer of the fragments from Mafungabusi was not illustrated, and for this reason the description is repeated here.

The tiny fragments consist of a seed-like body, E, together with a group of scale-like leaves or cone-scales, A, G, etc., which appear to have been in attachment around an axis. The material scattered through the sandstone would represent a disintegrated reproductive shoot in which scale-like bracts were borne, perhaps spirally, on a stalk, each one enclosing a seed. This last named is exemplified by E, Plate XXXI, fig. 2 (magnified three times), a pear-shaped body of the *Cordaicarpus* type, 6 mm. in length, pointed at one end, showing a convex surface with longitudinal fluting representing the nucellus, surrounded by a narrow winged border. Close beside are the scale-like leaves, A and G, Plate XXXI, figs. 3, 4—the second of these strongly convex—with surfaces exhibiting fine longitudinal veins diverging from the pointed end. The exact manner of attachment to the axis cannot be made out.

Comparison can be instituted with the form cited, which is known from the Rhaetic of Sweden and Persia ; it agrees well with Nathorst's figures, which show the pointed and striated character of the cone-scales.

The interior of the scale-leaf A actually shows the structure without further treatment of the thick epidermis, which is figured under a high magnification in 5. The cells are polygonal between the veins, but rectangular or elongated over the latter, while the perforations taken to be stomata are each one surrounded by a well-defined ring built up of from 4 to 5 accessory cells, which must hide the two guard-cells. Among the relatively few fossil plants in which such an ususual arrangement is to be found stands the genus *Thinnfeldia*, the guard-cells thereof being generally sunk within the cuticle, and sometimes only just detectable beneath the ring of accessory cells, which are usually 5 in number.* This structure is exactly reproduced in certain gymnosperms—for example, in the living *Phyllocladus*. The cuticle in *Cyparissidium* has not yet been studied, but in the comparable form from the Rhaetic of Germany, *Brachyphyllum münsteri* †—since placed under *Cheirolepis* ‡—which resembles in certain respects the Rhodesian plant, but has the cone-scales digitate at their edges, the epidermal cells are polygonal, and a ring of 5 accessory cells surrounds each stoma. It can therefore be presumed

* Antevs, 1914, pp. 27–28.

† Schenck, 1868, p. 187, pl. xliii, figs. 1–12.

‡ Seward, 1919, p. 294.

that an analogous structure would be represented in *Cyparissidium*, and the South African plant is hence referred to that genus, and provisionally placed with Nathorst's species.

It might be pointed out that in certain living plants that are exposed to drought or insolation the guard-cells are surrounded by a collar of accessory cells, or lie below the latter, and may even be nearly shut off from the surface of the leaf, though it is true that similar "xerophytic" structures may also be developed in certain plants that flourish in salt swamps. In view, however, of the deduction to be drawn from fairly reliable internal evidence that the Forest Sandstone has been accumulated under a semi-arid climate, there is more than a fair presumption that the peculiar cell arrangement observed in these cone-scales represents actual adaptations to resist the influences of drought.

The specimens figured here are preserved in the Geological Survey Collections, Salisbury, Rhodesia.

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IX.—INDEX TO GENERA AND SPECIES DESCRIBED.

S

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V

Z

EXPLANATION OF PLATES.

Plate XVI.

FIG.

1. *Equisetites* cf. *platyodon* (Brong.), 8330; × 2 times.
2. *Neocalamites carreri* (Zeill.), 8329; 1, exterior of stem between nodal lines; 2, interior of stem; 3, diaphragm; 4, leaf-whorl; 5, leaf scars.
3. *Neocalamites carreri*, Zeill., 5806; exterior of stem.

Plate XVII.

1. *Cladophlebis concinna* (Presl) 6198,; × 4 times.
2. *Taeniopteris crassinervis* (Feist.), 8653; × $1\frac{1}{2}$ times.
3. *Taeniopteris nilssonioides*, Zeill., 5812–4.

Plate XVIII.

1. *Marattiopsis münsteri* (Göpp.), 8324.
2. ,, ,, ,, ,, ; × 2 times.
3. *Thinnfeldia narrabeenensis*, Dun (MS.), 8321.

Plate XIX

1. *Stenopteris elongata* (Carr.), 8252.
2. *Pachypteris acuta*, sp. nov., 8319.

Plate XX.

Ginkgoites magnifolia (Font.), 8254.

Plate XXI.

1. *Ginkgoites magnifolia* (Font.), 5909.
2. *Pseudoctenis carteriana* (Old.), 8266.
3. *Voltzia* cf. *liebeana*, Gein., 5824–5.

Plate XXII

1. *Callipteridium africanum*, sp. nov., 6617.
2. *Pterophyllum multilineatum*, Shirl., 5901.
3. *Pseudoctenis fissa*, sp. nov. 8669.

Plate XXIII.

1. *Pseudoctenis* cf. *balli* (Feist.), 8315; reduced 5-6ths
2. *Pseudoctenis spatulata*, sp. nov.
3. ,, ,, ,,
4. *Elatocladus* sp., 8333.

Plate XXIV.

1. *Pterophyllum* (*Anomozamites*) *inconstans* (Braun), 8325.
2. *Pseudoctenis spatulata*, sp. nov., 6194.
3. *Conites charpentieri*, Zeill., 8648.

Plate XXV.

Danaeopsis hughesi, Feist.

Plate XXVI.

1. *Danaeopsis hughesi*, Feist.
2. *Callipteridium africanum*, sp. nov.
3. ,, ,, ,,

Plate XXVII.

Callipteridium africanum, sp. nov., 6106.

Plate XXVIII.

Lepidopteris cf. *stuttgardiensis* (Jaeg.), 6148; reduced 5-6ths.

Plate XXIX.

1. *Taeniopteris lata*, Old., 6084; half natural size.
2. *Taeniopteris magnifolia*, Rogers, 6085.
3. *Sagenopteris* sp.; 8332.

Plate XXX.

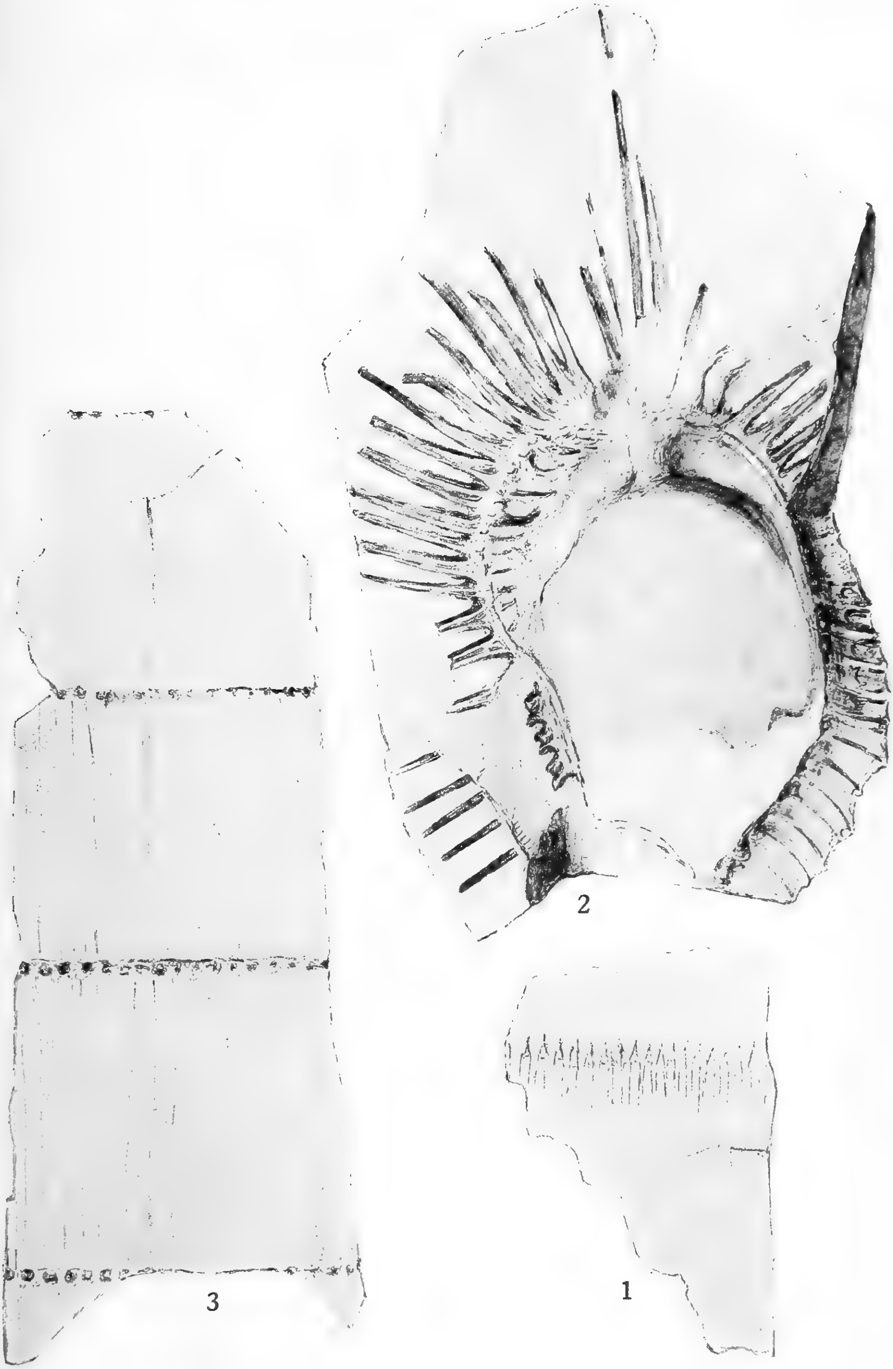
Ginkgoites magnifolia (Font.), 6143.

Plate XXXI.

1. *Zamites* cf. *rajmahalensis* (Morr.), 6120 and 6191.
2. *Cyparissidium* cf. *nilssonianum*, Nath.; × 3 times; seed.
3. ,, ,, ,, ,, ,, cone-scale; G, exterior.
4. ,, ,, ,, ,, ,, ,, A, interior.
5. ,, ,, ,, ,, highly magnified; structure of epidermis of cone-scale A.

Plate XXXII.

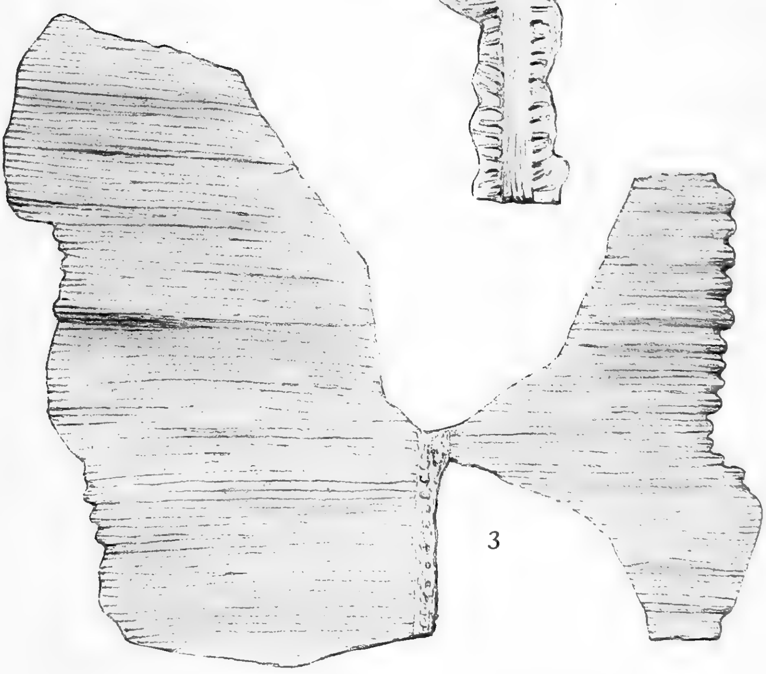
1. *Nilssonia browni*, sp. nov., 6134.
2. *Equisetites* sp.; nodal diaphragm.



1, *EQUISETITES* cf. *PLATYODON* ; 2, 3, *NEOCALAMITES CARRERI.*

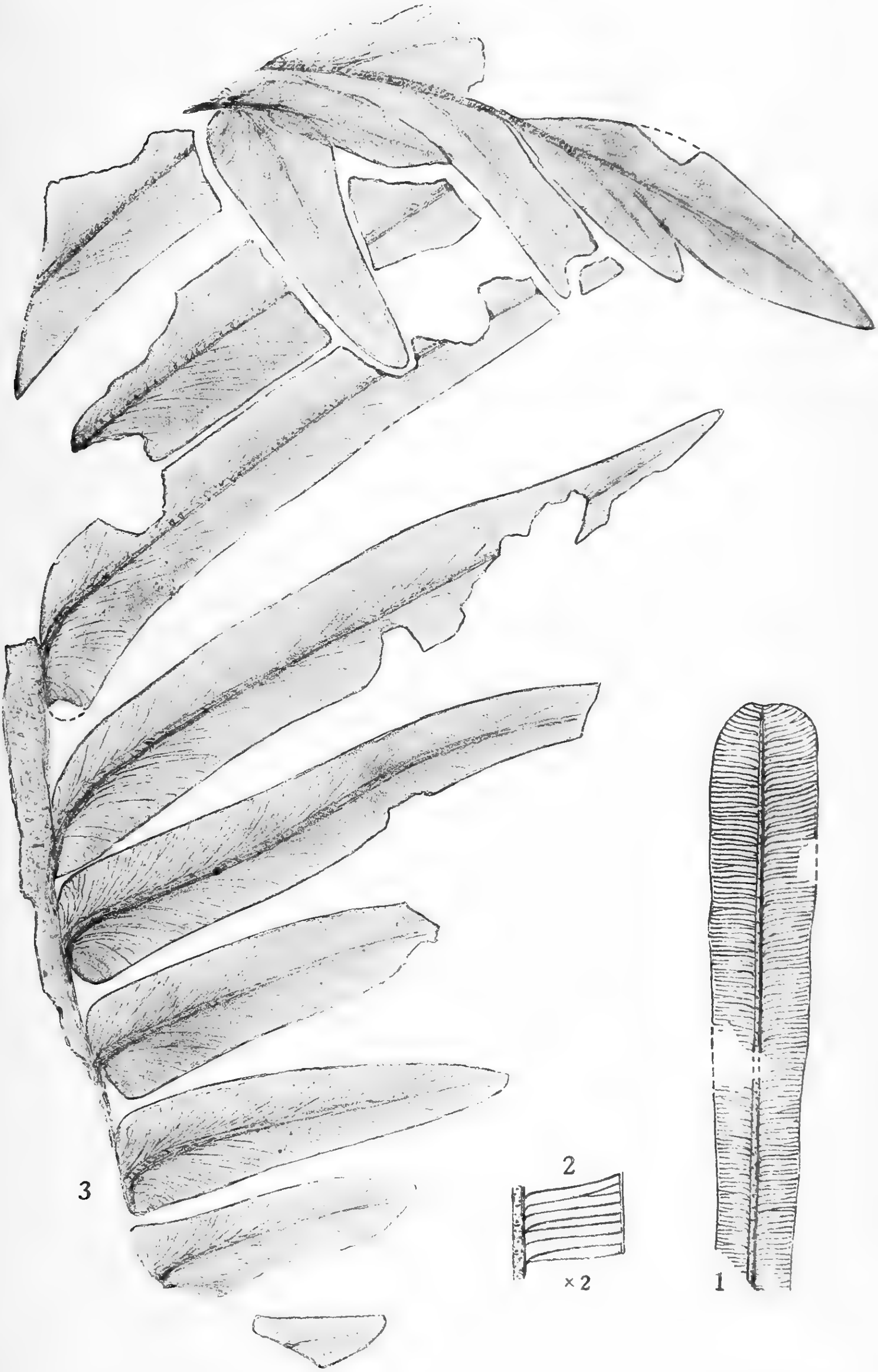
1

2

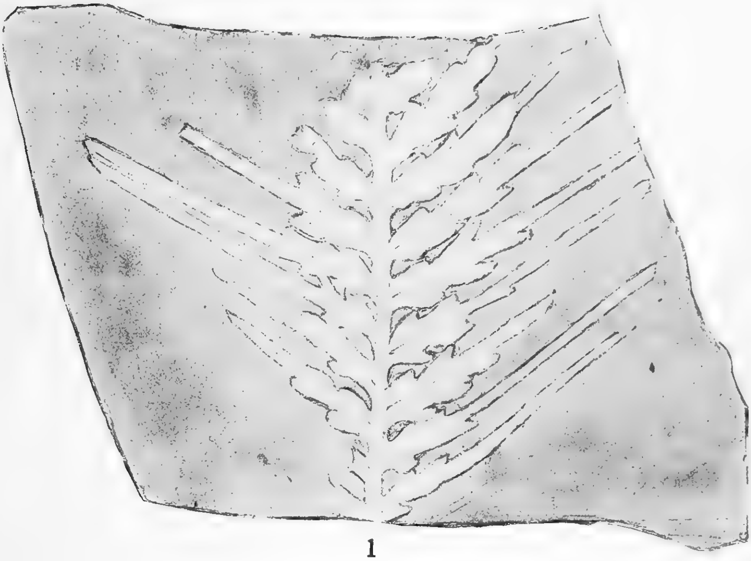


3

1, *CLADOPHLEBIS CONCINNA*; 2, *TAENIOPTERIS CRASSINERVIS*; 3, *TAENIOPTERIS NILSSONIOIDES*.



1, 2, *MARATTIOPSIS MÜNSTERI* ; 3, *THINNFELDIA NARRABEENENSIS*.



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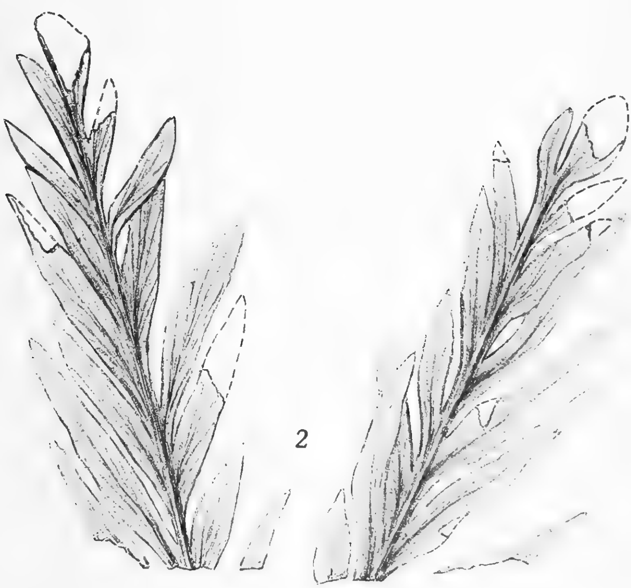
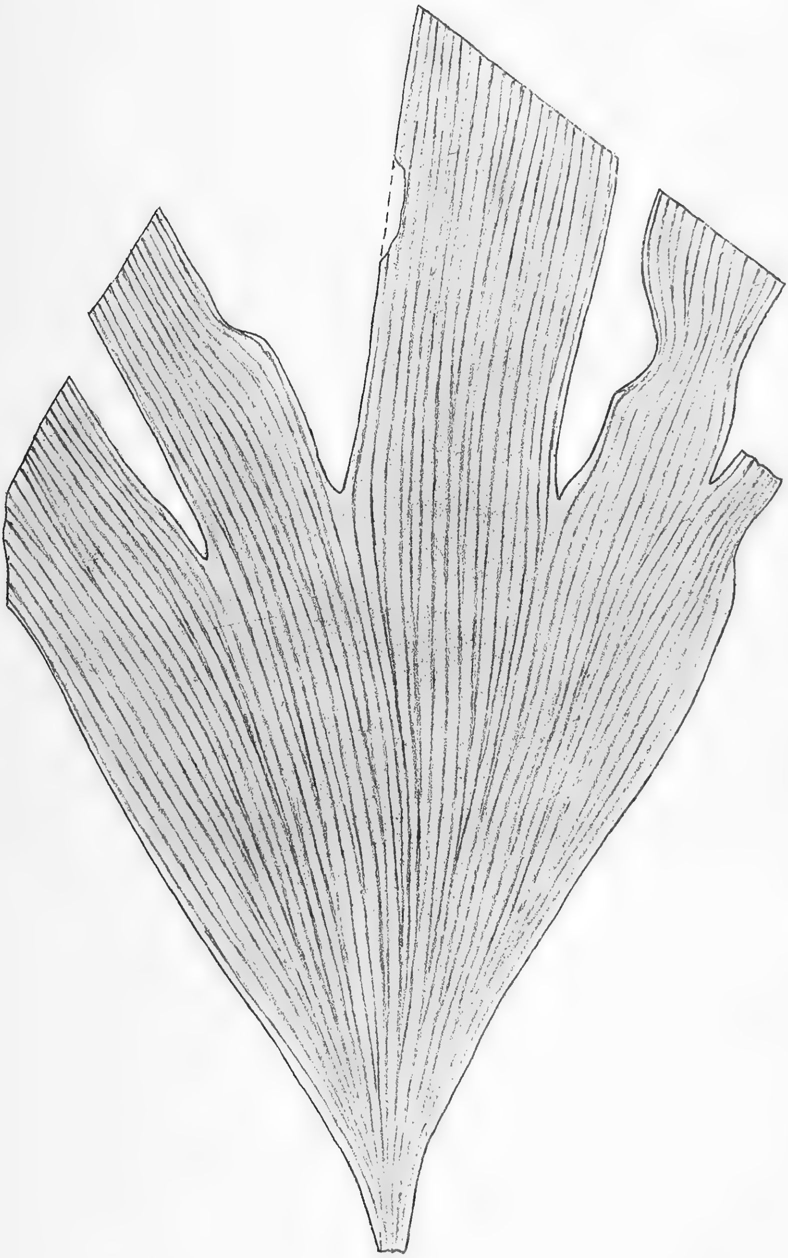


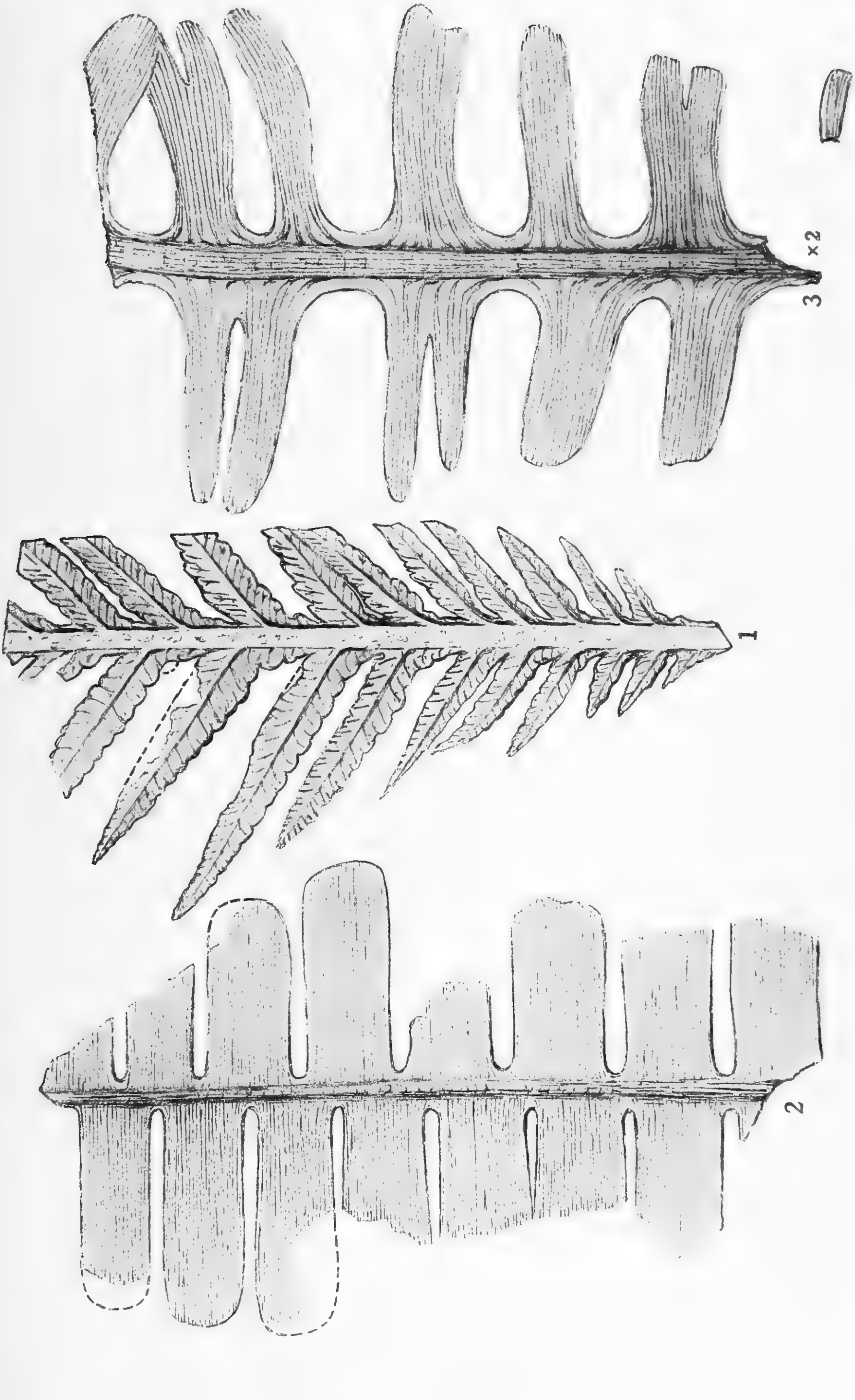
2

1, *STENOPTERIS ELONGATA* ; 2, *PACHYPTERIS ACUTA*.

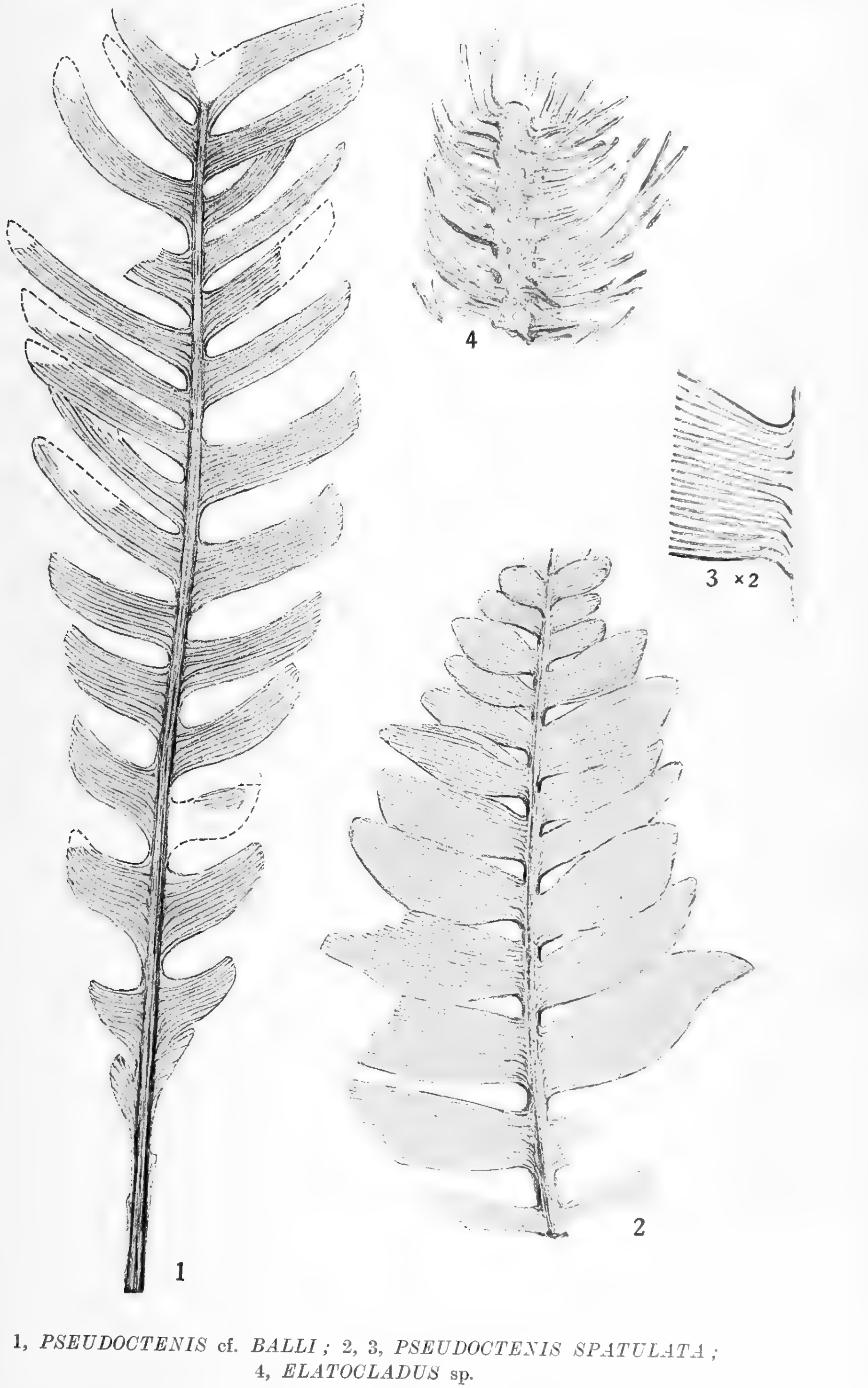


GINKGOITES MAGNIFOLIA.

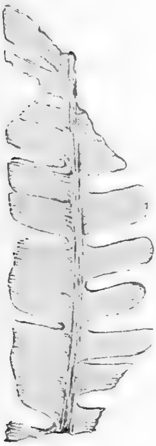
1, *GINKGOITES MAGNIFOLIA*; 2, *PSEUDOCTENIS CARTERIANA*;
3, *VOLTZIA* cf. *LIEBEANA*.



1, *CALLIPTERIDIUM AFRICANUM*; 2, *PTEROPHYLLUM MULTILINEATUM*; 3, *PSEUDOCTENIS FISSA*.



1, *PSEUDOCTENIS* cf. *BALLI* ; 2, 3, *PSEUDOCTENIS SPATULATA* ;
4, *ELATOCLADUS* sp.



1

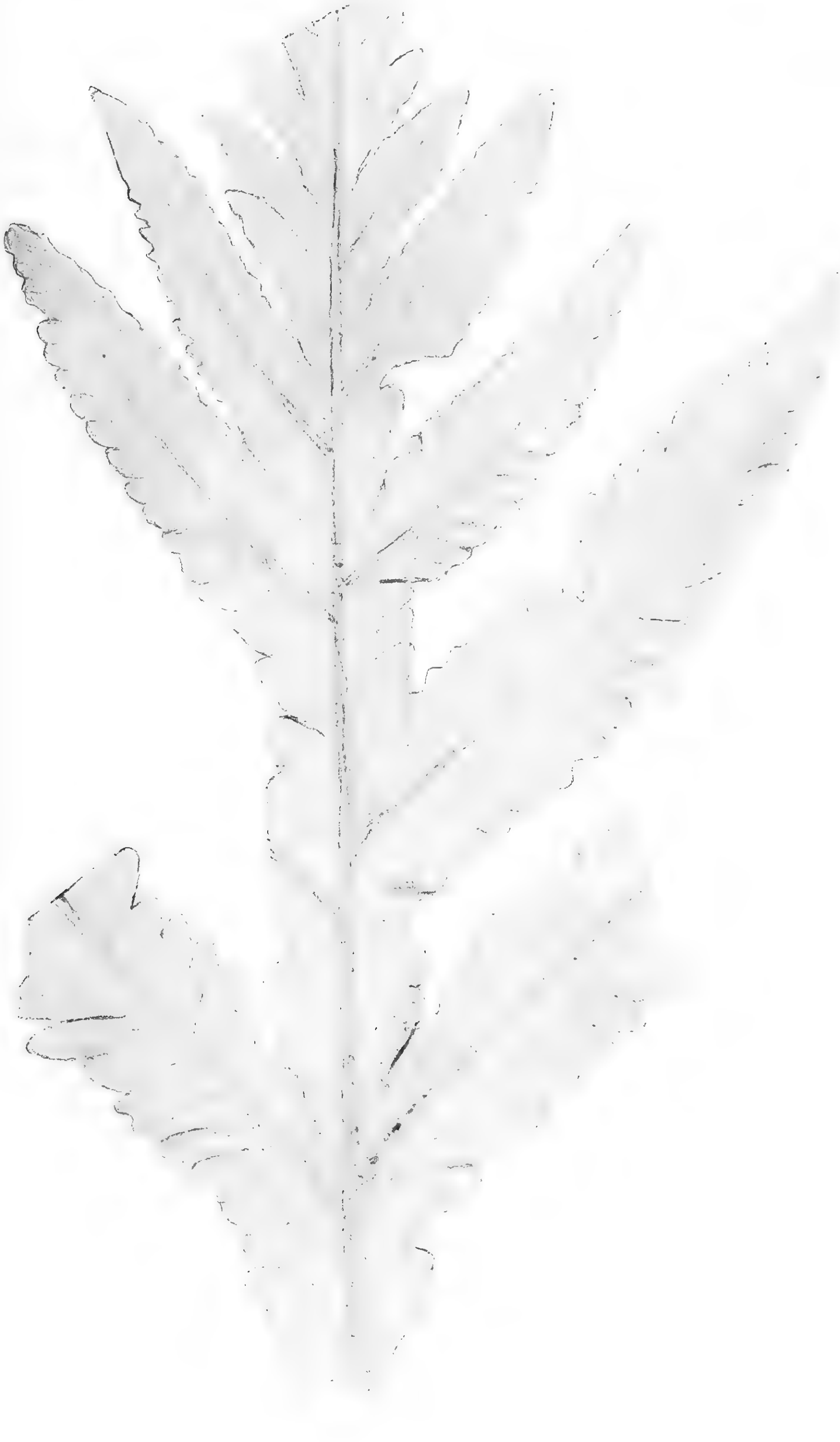
2

3 ×2

1, *PTEROPHYLLUM (ANOMOZAMITES) INCONSTANS*; 2, *PSEUDOCTENIS SPATULATA*; 3, *CONITES CHARPENTIERI*.

DANAEOPSIS HUGHESI.

1, *DANAEOPSIS HUGHESI*; 2, 3, *CALLIPTERIDIUM AFRICANUM*.



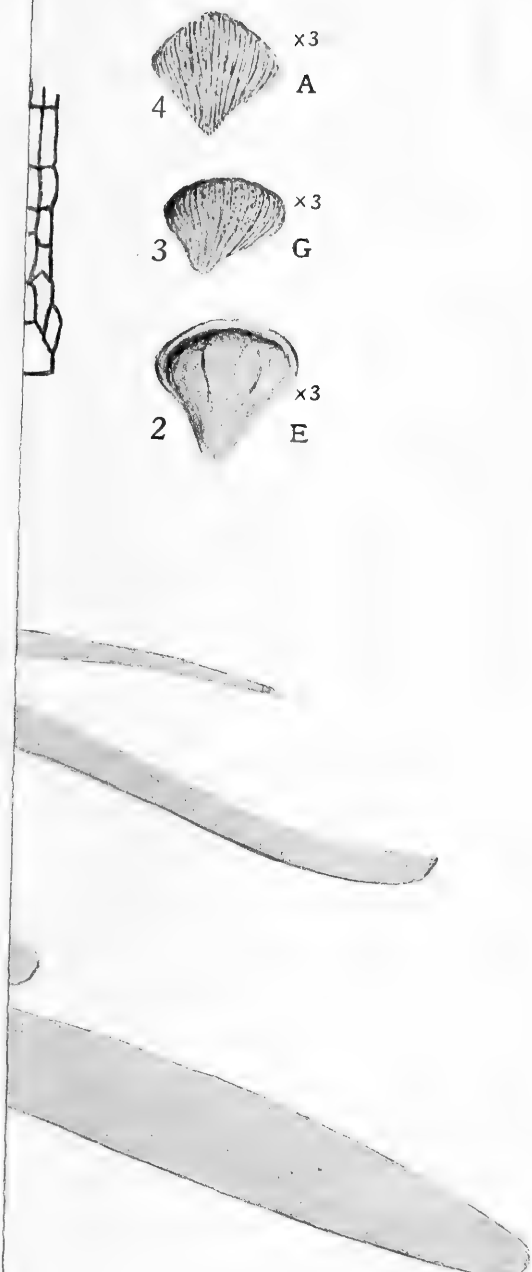
CALLIPTERIDIUM AFRICANUM.

LEPIDOPTERIS STUTTGARDIENSIS.

2

1, *TAENIOPTERIS LATA*; 2, *TAENIOPTERIS MAGNIFOLIA*; 3, *SAGENOPTERIS* sp.

GINKGOITES MAGNIFOLIA.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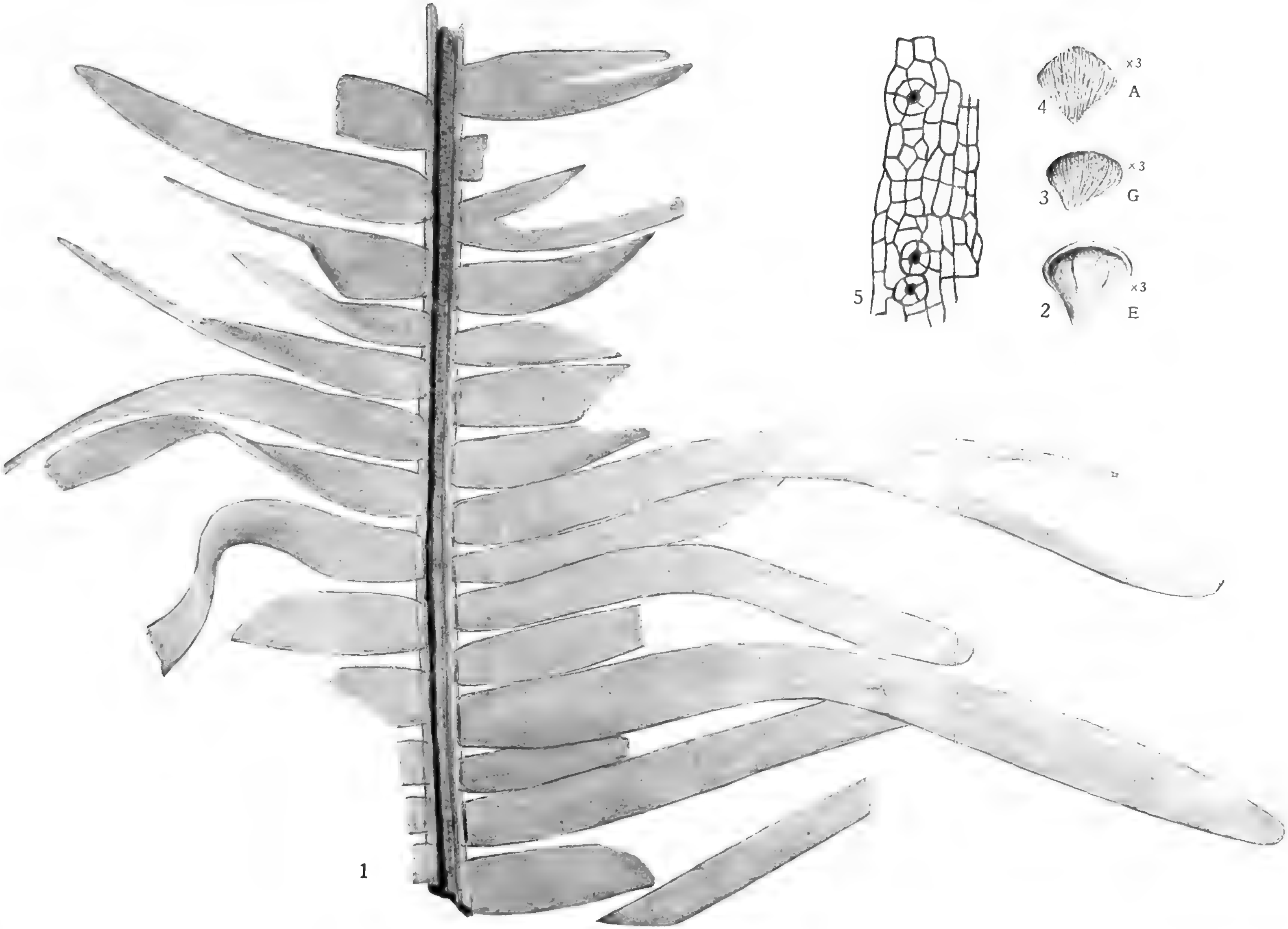
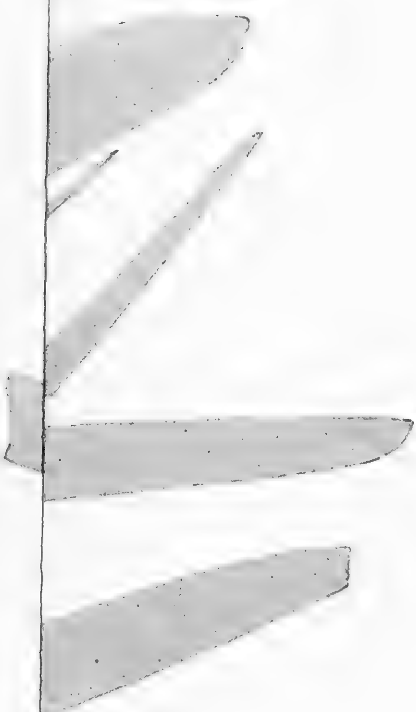
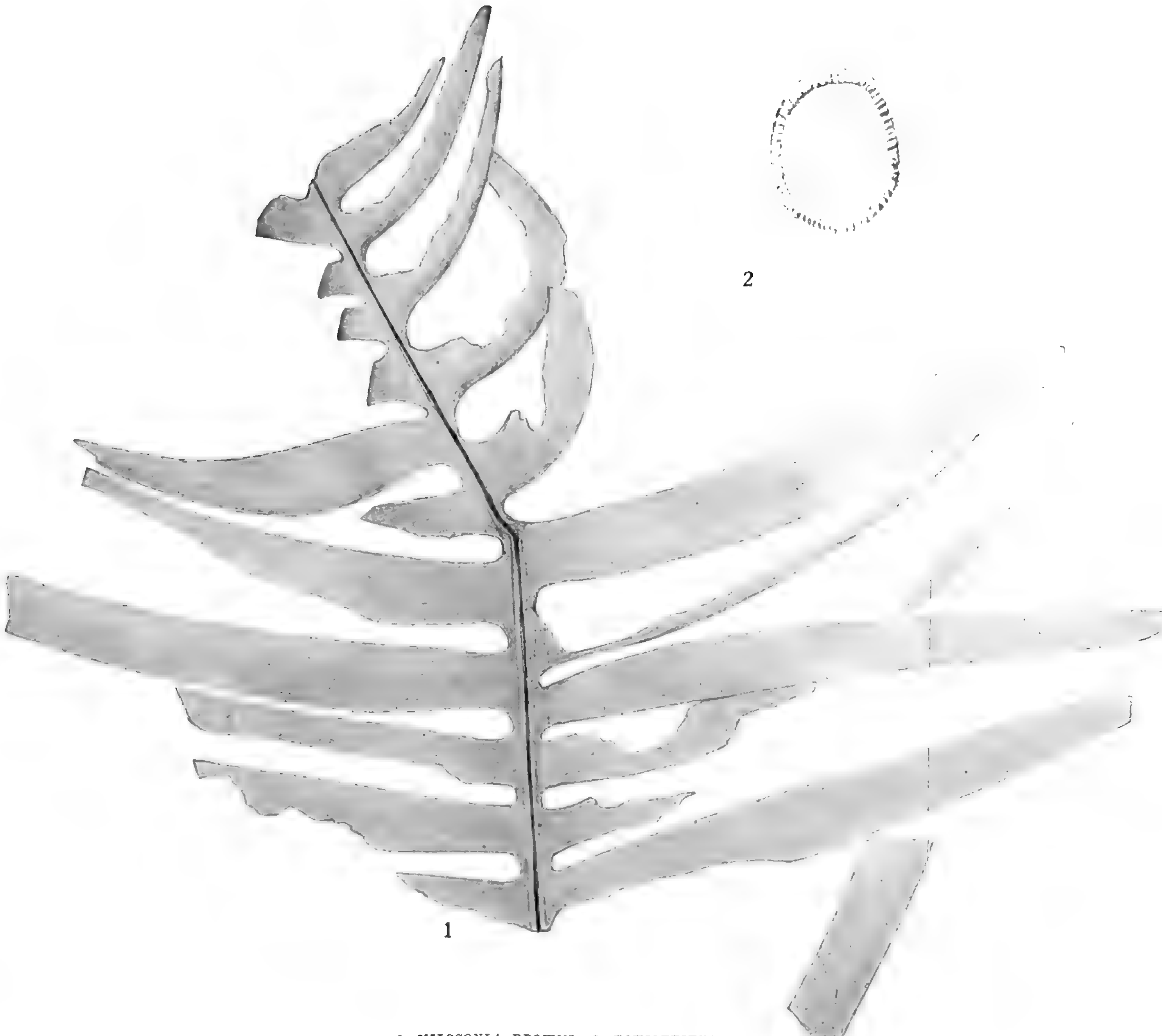


1, *ZAMITES* cf. *RAJMAHALENSIS*; 2–5, *CYPARISSIDIUM* cf. *NILSSONIANUM*.





1, *NILSSONIA BROWNI*; 2, *EQUISETITES* sp.

ANNALS

OF THE

SOUTH AFRICAN MUSEUM

VOLUME XXII

DESCRIPTIONS OF THE PALAEONTOLOGICAL MATERIAL COLLECTED BY THE SOUTH AFRICAN MUSEUM AND THE GEOLOGICAL SURVEY OF SOUTH AFRICA

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6. *On Three New Species of Dicynodon.*—By R. Broom, D.Sc., F.R.S.

(With 3 Text-figures.)

The three species of *Dicynodon* which are herein described have all been discovered by me during the last ten years, and in the case of each I have hesitated to describe as new a form that might perhaps belong to a species already known. On most careful consideration I have now come to the conclusion that each is new.

Dicynodon milletti sp. nov.

This new species was discovered by me at Sekretaris Kraal, between Biesjespoort and Murraysburg. It consists of a very fine skull with a good many bones of the postcranial skeleton. For a time I thought it might be regarded as a variety of *Dicynodon andrewsi*, but as it is manifestly a new species I am naming it after Mr. W. Millett of Sydney-on-Vaal, who takes a keen interest in the Tertiary fossils of the Diamond Gravels.

The skull is moderately flat and broad. From the back of the squamosal to the front of the snout it measures 290 mm., and the greatest breadth across the squamosals is 268 mm.

The snout is short, and, although slightly flattened in the specimen by crushing, must have been originally shallow. From the front of the orbit to the front of the snout the measurement is 80 mm. The nostril is large, measuring 27 mm. by 16 mm. The septomaxillary is within the nostril and does not appear on the facial surface. Above the posterior border of the nostril, doubtless on the nasal bone, is a well-developed elongated boss. Behind this nasal boss and a little outside of it is a second smaller boss on the prefrontal protecting the anterior upper border of the orbit.

The frontal region is slightly concave. The interorbital measurement is 43 mm. The postorbital bar is slender and passes almost directly outwards on the same plane as the frontals and parietals. The postfrontal is a triangular bone situated above the upper posterior corner of the orbit. The relations of the bones in the region

of the pineal foramen will be best understood from the figures given. Although the parietals are broader than in most Dicynodons, they are narrower than in *Dicynodon andrewsi*, the species with which it has perhaps most affinity. Further, the interparietal does not extend backwards as in *D. andrewsi*.

Dicynodon milletti is doubtless from the upper part of the *Endo-*

Fig. 1.—Skull of *Dicynodon milletti*, Broom. About $\frac{1}{3}$ natural size.

thiodon zone. *Dicynodon andrewsi* is from the top of the *Endothiodon* zone, and *Dicynodon kolbei* is also probably from the same zone. In affinities, *D. milletti* is in most respects intermediate between *D. andrewsi* and *D. kolbei*.

Dicynodon vanderbyli sp. nov.

This new species is founded on a moderate-sized skull discovered near New Bethesda Road Station by me some years ago. About half a dozen good skulls were found, but I was inclined to regard them

as belonging to *Dicynodon platyceps*, Broom until recently. But having at present a fine skull of *D. platyceps* for comparison, I have been forced to the conclusion that the two forms are quite distinct. I am therefore naming this New Bethesda Road type after Mr. W. van der

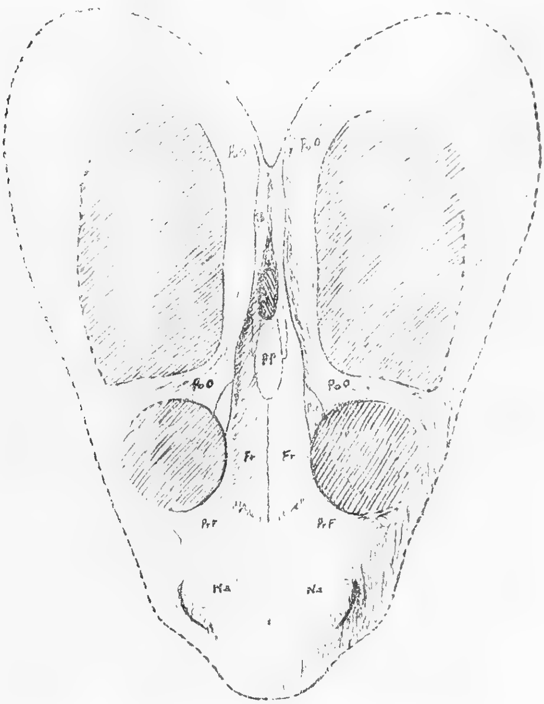

Fig. 2.—Skull of *Dicynodon vanderbyli*, Broom. About ¼ natural size

Byl of Abraham's Kraal, to whom South African palaeontology owes so much.

The type skull when complete measured probably from the back of the squamosal to the front of the snout about 320 mm. From the back of the pineal foramen to the front of the snout is 200 mm. The interorbital measurement is 45 mm.

The pre-orbital portion of the skull is short but unusually massive. There is a small boss over each nostril, and the supra-orbital margin in the prefrontal region is considerably raised and thickened. There are no tusks in the type nor in any of the other known skulls, though a young skull that probably belongs to the same species, and found

in association with the larger skulls, has a pair of small tusks. We may thus conclude that both sexes in the adult condition are tuskless as we find in *Dicynodon platyceps*.

Perhaps the most striking character of *Dicynodon vanderbyli* is the deep hollowing out of the preparietal region. All sections across the orbits show the orbital margins much everted and the frontal region irregularly concave, though slightly raised in the middle line. A section across the middle of the preparietal cuts on each side a very prominent ridge formed along the suture between the frontal and the postorbital, and the preparietal lies 10 mm. below the tops of the ridges.

The postfrontal is a small bone wedged in between the frontal and the postorbital. The postorbital is unusually large. It forms a very prominent outstanding postorbital margin, and on passing backwards forms the whole of the upper temporal margin. Between the two postorbitals the parietals appear as if much crushed, and only a small part of each appears on the upper surface.

The horizon of *Dicynodon vanderbyli* is probably about the middle of the *Cistecephalus* zone.

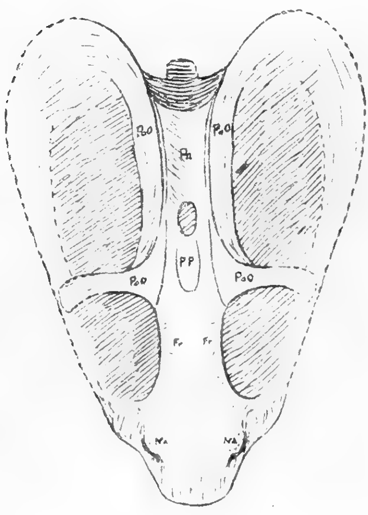

Fig. 3.—Skull of *Dicynodon wilmanae*, Broom. About ½ natural size.

Dicynodon wilmanae sp. nov.

This new species is founded on a small skull discovered by me on the side of the high mountain about 2½ miles east of Biesjespoort station and probably about 500 feet above the horizon of the station. As the station is as near as may be at the top of the *Endothiodon* zone, this new species may be regarded as being situated about 500 feet up in the *Cistecephalus* zone.

The only *Dicynodon* which it resembles is *Dicynodon mustoi*, but as this latter is certainly from the middle of the *Endothiodon* zone, 1000 feet must separate the two allied forms.

As the form is clearly new, I have much pleasure in naming it after Miss M. Wilman, Curator of the Kimberley Museum, who for many years has taken an active part in stimulating research in South Africa.

The skull measures in greatest length about 140 mm., and in greatest breadth about 90 mm. From the front of the orbit to the front of the snout is only 30 mm.

The most striking characters of the species are the relatively very small size of the beak and the narrowness of the interorbital region. There are no tusks, and the caniniform processes are only 30 mm. apart. There is only a very slight thickening over the nostrils, and the nostrils are only 20 mm. apart.

The interorbital measurement is 19 mm. The whole frontal and preparietal regions are moderately flat. The sutures of the post-frontals are not apparent. The intertemporal region is moderately wide. The general relations of the bones will be best understood from the figure given.

The types of this and the other two species belong to the Kimberley Museum.

7. *On Tapinocephalus and Two Other Dinocephalians.*—By R. Broom, D.Sc., F.R.S.

(With 7 Text-figures.)

Tapinocephalus atherstonei, Owen.

In 1876 Owen gave the name *Tapinocephalus atherstonei* to a large rather flat snout that had been discovered by Dr. W. G. Atherstone a few years previously near Jan Willem's Fontein in the Prince Albert District, South Africa. As no teeth are satisfactorily preserved in the specimen, and the only other apparently associated remains are a fragment of the dentary and a fragmentary vertebral centrum not figured, it will be seen that the type is far from a good one.

From time to time imperfect skulls have been discovered of forms allied to *Tapinocephalus*. Seeley, when in South Africa, obtained with the assistance of Mr. T. Bain a good skull and a very imperfect one of allied Dinocephalians. Dr. Atherstone had presented to the British Museum in 1872 a considerable number of bones of large Dinocephalians, but these, though believed to be associated, are pretty certainly the remains of more than one animal. A fairly complete pelvis was in 1889 made by Seeley the type of *Phocosaurus megischion*, but this same specimen, with other bones from Vers Fontein, are provisionally referred by Lydekker to *Tapinocephalus atherstonei*, and by Owen they were referred to *Pareiasaurus bombidens*.

The good Dinocephalian skull discovered by Seeley I described briefly in 1910 and referred it to *Tapinocephalus*. This same skull Watson, in 1914, described as a new genus and species *Mormosaurus seeleyi*.

In 1913 Haughton described and figured a very fine skull, which he referred to *Tapinocephalus atherstonei*; and in 1915 he described under the name *Struthiocephalus whaitsi* a fine skull of another Dinocephalian allied to *Tapinocephalus*; and the same year he mounted in the South African Museum a nearly complete skeleton of a smaller *Struthiocephalus*, and published a figure of the skeleton in the Annual Report of the Museum for 1915.

In 1912 I had described under the name *Taurops macrodon* the snout of another ally of *Tapinocephalus.*

It will be seen that owing to the unsatisfactory condition of the type of *Tapinocephalus atherstonei*, and to our having no certain knowledge of the postcranial bones that belong to the snout, our knowledge of the genus is in a most confused condition, and until quite recently bones that belong to *Tapinocephalus* or a near ally have been referred to *Titanosuchus* or an allied form, and *vice versa.*

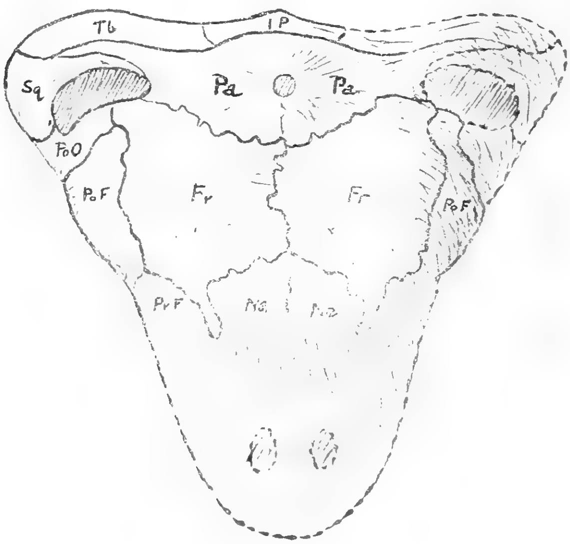

Fig. 1.—Skull of *Tapinocephalus atherstonei*, Owen. $\frac{1}{6}$ natural size.

All that has been known for certain are what bones belong to *Pareiasaurus* and what bones belong to *Struthiocephalus.*

Recently I have been working out the skeleton of certain Titanosuchids, especially *Jonkeria truculenta* of Van Hoepen, and a number of associated bones in the collection of the South African Museum, and some others in my own collection, and this has led to an almost complete knowledge of the postcranial bones of the Titanosuchids, which is a very important additional step in our knowledge.

Though the postcranial bones of *Tapinocephalus* are less satisfactorily known, some associated remains in the South African Museum and in my own collection help considerably in clearing up the confusion.

The skull of *Tapinocephalus* described by Haughton, though nearly perfect, is, like most remains from the *Tapinocephalus* horizon, in a most intractable matrix, and nothing can be made out of the sutures. Fortunately I have in my possession a less perfect skull also in a flinty hard matrix, but weathered out on top and showing beautifully most of the upper sutures.

The skull which I have was shown to me at Gans Kraal by Mr. M. J. van Wyk of Kookfontein. Like the skull described by Haughton, it is remarkably broad in comparison with the length. The breadth

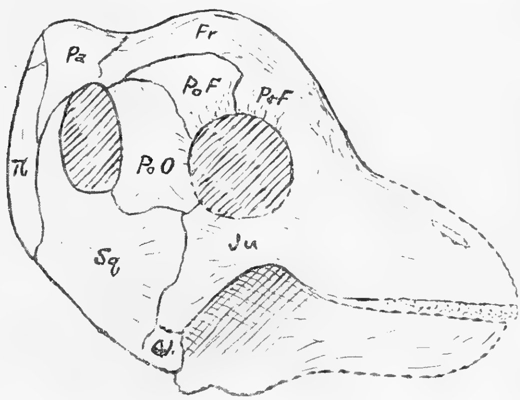

Fig. 2.—Side view of skull of *Tapinocephalus atherstonei*, Owen. $\frac{1}{6}$ natural size.

is about 440 mm., and though, as the greater part of the snout is lost, the length is uncertain it may be estimated at about 450 mm. The height from the lower side of the occipital condyle to the top of the parietal is 240 mm.

The top of the skull is almost perfectly preserved, and it is mainly formed by six bones—a pair of parietals, a pair of frontals, and the upper and posterior parts of the nasals.

The parietals are very much broader than long. Between them is a rather small pineal foramen. In front the parietal meets the frontal by a fairly long suture, but apparently does not meet the postorbital, at least not on the surface of the skull, being separated from it by the outward extension of the frontal. The parietal forms the upper wall of the narrow temporal fossa, and behind the fossa extends far outwards between the squamosal and the tabular.

The frontal is an irregular pentagonal bone, with a long suture

behind with the parietal, a shorter suture with its neighbour in the middle line, a suture with the nasal and the prefrontal, and a rather longer suture with the postfrontal. The posterior and outer corner passes out between the parietal and the postfrontal and has a short suture with the postorbital. At the anterior and outer corner is a long, narrow process which passes forwards, dividing the nasal from the prefrontal. On the top of the skull the posterior part of the frontal is considerably lower than the anterior or than the middle part of the parietal, and there is thus formed a transverse hollow.

The postfrontal is a large, thick triangular bone which forms much of the upper margin of the orbit. It meets on its upper side the frontal and posteriorly the postorbital, and in front it has a short suture with the prefrontal.

The postorbital forms part of the postorbital wall, but apparently not very much. In front it articulates with the postfrontal and above with the frontal, at least on one side, by a very short suture. Probably there is also an articulation with the parietal on the upper temporal wall. Below the temporal fossa there is a short articulation with the squamosal, and probably a shorter one with the jugal.

The squamosal, as in all Dinocephalians, is large. In general structure it seems to agree with that of *Moschops*. The upper part forms most of the posterior wall of the temporal fossa. A thin process passes up on the anterior side of the posterior process of the parietal. There is only apparently a short anterior process, and the descending process, though probably well developed, is not very satisfactorily preserved.

The jugal is not well seen, but is fairly well preserved on the right side. Under the orbit it is a moderately deep flat bone, and on passing backwards it bends downwards and has a long articulation with the squamosal.

The interparietal is fairly large and well preserved. Its upper end appears on the top of the skull, and the whole of the middle of the upper half at least of the occiput is formed by it.

The tabular is a large flat bone which forms about two-fifths of the upper half of the occiput, and whose upper end forms a part of the upper surface of the skull. Above it articulates with the interparietal and the parietal, and its outer end lies in front of the squamosal.

There is a considerable portion of the maxilla preserved with the rest of the skull, but it has not yet been cleared of the hard matrix. A portion of the anterior part of the bone with some tooth

sockets is also preserved, but without contact with the posterior portion.

Owing to the unsatisfactory condition of the snout in the British Museum type, and to its being the only part of the skull known, it is a matter of the greatest difficulty to determine satisfactorily other specimens. Haughton's specimen may or may not be the same species. Most probably it is the same genus, and for our present purpose this is sufficient. My specimen may or may not be the same species as Haughton's, but almost certainly it is the same genus and may be regarded as pretty certainly *Tapinocephalus*, and very probably *T. atherstonei.*

Although no bones are at present known that have been found in certain association with a skull, we have three series of bones that almost certainly belong to *Tapinocephalus*. In the South African Museum are much of a pelvis, a few vertebrae, and a good femur. In my own collection are a good series of vertebrae with a bad pelvis, and a second very fragmentary skeleton of a somewhat smaller and possibly young animal with portions of many bones of the skeleton, but with no parts of the skull.

The vertebrae of *Tapinocephalus* and the allied *Struthiocephalus* differ from those of *Titanosuchus* and its allies in having the centra much flatter, and the antero-posterior measurement thus much less than the breadth. In the Titanosuchids the antero-posterior length of the centrum nearly equals the breadth. In *Tapinocephalus* the transverse processes in the dorsal vertebrae are very much more developed than in the Titanosuchids.

I have an isolated scapula which I believe to be the scapula of *Tapinocephalus*, but as there are no bones associated with it, it will be well to leave it at present undescribed.

It is fortunately possible to give a description of a nearly perfect humerus that is almost certainly the humerus of *Tapinocephalus*.

In 1876 Owen figured a well-preserved large humerus as the humerus of *Pareiasaurus bombidens*. Lydekker in 1890 referred this same specimen provisionally to *Tapinocephalus atherstonei*. In 1889 Seeley figured a different type of humerus (B.M. 49369) said to have come from Koodooskop and to have been found with the type skull fragments of *Titanosuchus ferox*. It was naturally assumed if that determination were correct, most probably the reference of the short, massive type to *Tapinocephalus* by Lydekker was also correct, and I thus referred the American Museum shoulder girdle specimen figured by me in 1914 to *Tapinocephalus atherstonei*. Now our nearly

complete knowledge of the skeleton of *Titanosuchus* and its near allies *Jonkeria, Dinophoneus*, etc., proves that the humeri we regarded as belonging to *Tapinocephalus* are really the humeri of Titanosuchids. And the humerus and most of the other bones which Seeley and Lydekker regarded as belonging to *Titanosuchus ferox* are found to be really the bones of *Tapinocephalus* or a near ally. Manifestly the bones said to have been associated with the type skull fragments

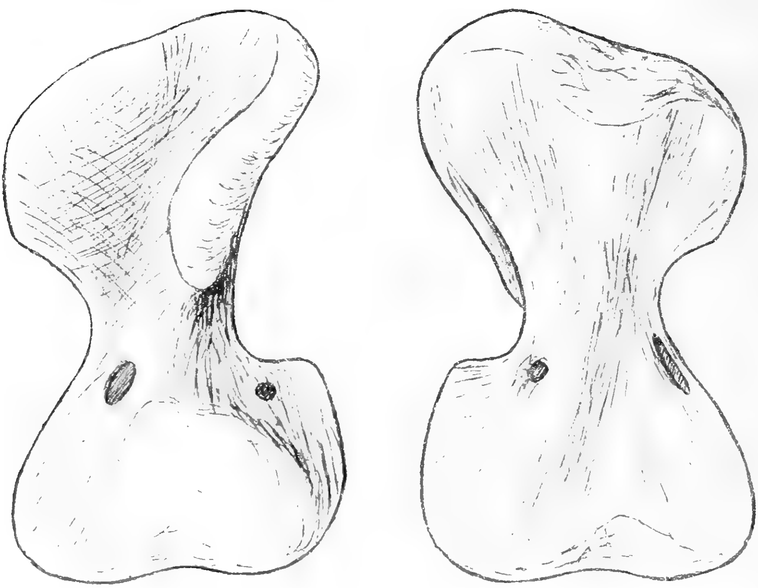

FIG. 3.—Anterior and posterior views of left humerus of *Tapinocephalus atherstonei*, Owen. About $\frac{1}{7}$ natural size.

of *Titanosuchus ferox* cannot be those of one individual, as there are two left humeri. Further, the fibula figured by Seeley is manifestly not the fibula of a Titanosuchid, which differs very markedly. Mr. T. Bain has evidently done as Dr. Atherstone had done before him, collected what good bones he came across, and has not noted carefully the associations.

The humerus which I regard as that of *Tapinocephalus atherstonei* is a long bone 544 mm. in greatest length. The distal end has a width of 320 mm., and the greatest width of the upper half of the bone is also 320 mm. The general shape of the bone will be best understood from the figures given. It will be seen that in general shape and

structure it resembles considerably the humerus of the Anomodont *Dicynodon*. There are, however, a number of important differences. In *Dicynodon* the proximal articular surface is about the same distance from the distal end of the bone as is the inner tuberosity. In *Moschops* the articular surface is very much above this inner tuberosity, and *Tapinocephalus* agrees as we might expect with *Moschops*; but in *Tapinocephalus* the articular surface is still further removed from the tuberosity. The delto-pectoral crest is in *Tapinocephalus* much more powerfully developed than in *Moschops*. About the middle of the humerus on the posterior side is a very marked tuberosity for the attachment of a muscle. This pretty manifestly corresponds to the tuberosity about the middle of the inner side of the humerus of *Dicynodon* and is evidently for the attachment of the coracobrachialis. It is very well developed in the humerus of the Titanosuchids. As in Therapsids generally, there is a large entepicondylar foramen with, in addition—what we do not as a rule find in Therapsids—a well-developed ectepicondylar foramen. An ectepicondylar foramen is unknown in Cynodonts, Gorgonopsians, Therocephalians, Dromasaurians, and Anomodonts, and appears to be quite absent in *Moschops*. It is present in some Pelycosaurs. A small ectepicondylar foramen is, however, present in the Titanosuchid humerus, though it has not, I think, been previously recognised. The characters of the distal end of the humerus will be readily understood from the figures given.

The ulna is, like the humerus, a large well-developed bone. The ulna figured by Seeley in Phil. Trans., 1889, B, pl. xxii, is, judging by the figure, apparently the ulna of *Tapinocephalus atherstonei*. The supposed ulna which he figures on pl. xxiii is really the left tibia of a *Pareiasaurus*. Of course, when Seeley's paper was published the limb bones of *Pareiasaurus* were quite unknown. I have no perfect ulna, but I have the proximal half of one with the distal end and only a little piece of the middle missing.

The radius is broad and rather flat. In general, it agrees with that of *Moschops*, but is more massive.

The pelvis is not completely known. The South African Museum specimen has the greater part of the right ilium preserved with the acetabular part of the left ilium. My one specimen has portions of both ilia preserved, and the fragmentary skeleton has much of one ilium, though badly weathered. The South African Museum specimen has a nearly perfect left pubis and much of the left ischium; and my fragmentary skeleton has portions of both pubis and ischium. In the British Museum there is the good pelvis that has been made by

Seeley the type of *Phocosaurus megischion*. It has been figured by Seeley (Phil. Trans., 1888, B, pl. xxi), and by Lydekker in 1890. Unfortunately the figures do not agree as closely as one would like, the pubes in the two drawings differing very markedly, and it is impossible for one in South Africa to decide which is correct. Not improbably Lydekker is right in referring the specimen to *Tapinocephalus*. The ilium certainly agrees pretty closely with the South African Museum specimen, and it is certainly not the ilium of a Titanosuchid.

The shape and general structure of the ilium will be seen from the figure I give, which is from the better preserved specimen with the acetabular portion restored from the other.

The acetabular portion of the ilium is relatively very large, equalling about half of the whole ilium. The anterior wall of the acetabulum is more developed than the posterior. Above the acetabulum is a well-developed bony boss, as in *Moschops* and other early reptiles, with behind it a supra-acetabular notch. The upper half of the ilium has a short anterior process and a more developed posterior. Though in the present specimen the outer portion of the posterior process is imperfect, there is no doubt that, as in *Jonkeria*, it has a similar peculiar development in being curved or folded outward into a process which stands markedly out from the general surface of the ilium. A similar development seems to be present in the London specimen.

The greatest antero-posterior length of the ilium is 380 mm., and the width of the acetabular portion is 300 mm.; which measurements agree pretty closely with those of the London specimen.

The pubis resembles pretty closely the pubis of *Moschops* in general characters. The acetabular portion seems in the South African Museum specimen to be smaller than in the London specimen, but this may be due to the foreshortening in the drawing. In the specimen I am describing, the width of the upper end of the pubis is 220 mm. The maximum depth of the acetabulum is about 100 mm., and the distance from the upper border of the bone to the pubic foramen is 120 mm. The distance from the upper posterior corner of the acetabular surface to the anterior pubic process is 288 mm. The pubic foramen measures 70 mm. by 35 mm. The lower posterior part of the pubis is lost, and it is thus difficult to be sure of its shape. It does not appear to have had the symphyseal part curved in as in Seeley's diagram.

The ischial fragment is little more than the acetabular portion and does not help us much.

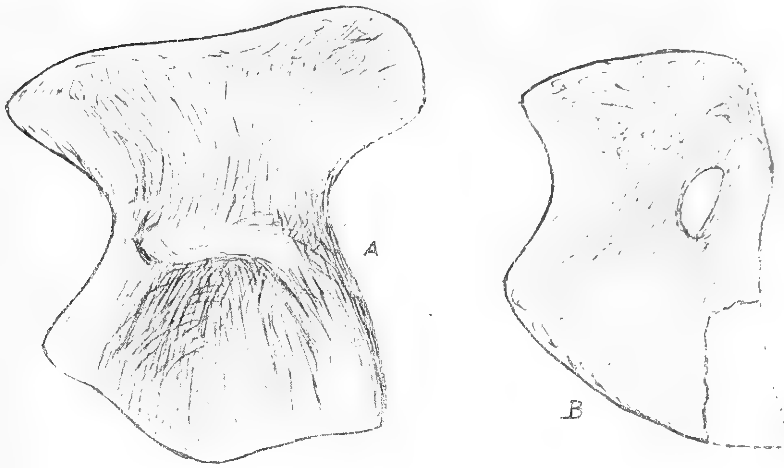

FIG. 4.—A, right ilium; and B, left pubis of *Tapinocephalus atherstonei*, Owen. $\frac{1}{7}$ natural size. (S.A.M. 5001.)

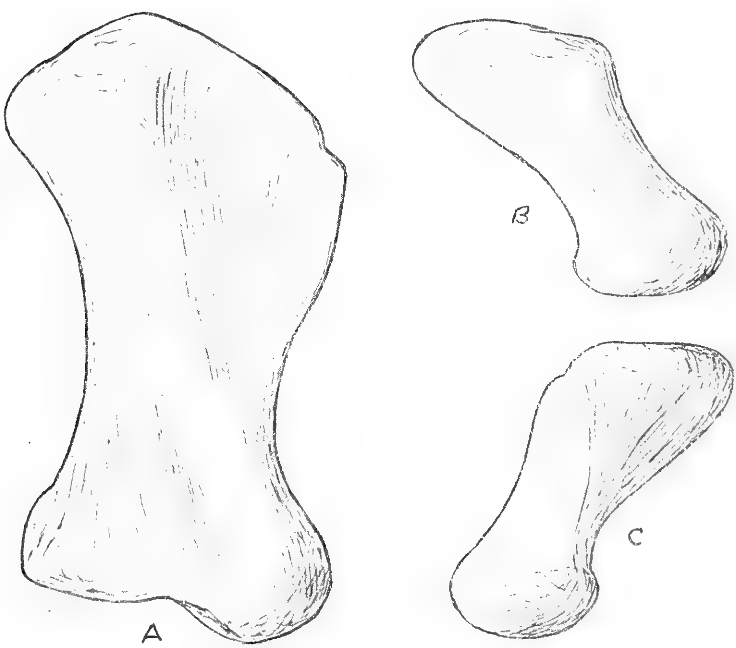

FIG. 5.—A, front view of left femur (S.A.M. 5001); B, inner view of right tibia; and C, outer view of right tibia of *Tapinocephalus atherstonei*, Owen. $\frac{1}{7}$ natural size.

The femur is beautifully preserved in the South African Museum specimen. It is a large, powerful bone, which agrees pretty closely with the femur of *Moschops*. Unfortunately it is somewhat crushed, and it is a little doubtful whether some of the features are natural or due to crushing. In greatest length it measures 570 mm. The upper end has a breadth of 310 mm., and the distal end a breadth of 270 mm. The great width of the upper end is due to a great expansion of the shaft into a comparatively thin plate, whose outer corner forms the great trochanter. The general proportions of the bone will be best understood from the figures.

The tibia is represented by two specimens, one perfect and the other represented by the two ends, with a small part of the shaft missing. The bone agrees in most characters with that of *Moschops*. The fibula is represented only by the two ends of one bone, with a portion of the shaft lost. It agrees closely with the fibula of *Moschops*. The greatest length of the tibia is 328 mm.; the greatest antero-posterior diameter of the proximal articulation is 166 mm., and the antero-posterior length of the distal surface is 140 mm. The proximal end of the fibula measures 123 mm. in antero-posterior length, and the distal end is 105 mm. in greatest length.

Tapinocephalus was a very massive, relatively short Dinocephalian, which stood about 4 feet in height, and in general proportions must have resembled somewhat a large hippopotamus.

Taurocephalus lerouxi gen. et sp. nov.

This new genus and species is founded on a good skull discovered by Mr. J. J. Leroux and his brother near the northern boundary of Abraham's Kraal, Prince Albert District, and in acknowledgment of the useful palaeontological work done by the Lerouxs, I have much pleasure in naming the specimen after them.

The skull is that of a Tapinocephalian allied to *Struthiocephalus*, but differing from it in having a much narrower frontal region, and in having a powerful beak instead of a flat slender one. The greatest length of the skull is about 500 mm., and the greatest width about 300 mm. The interorbital width is 140 mm.

In general structure the skull agrees pretty closely with *Moschops* and *Delphinognathus*. The temporal fossae are relatively small, and as in *Struthiocephalus* moderately close together. The parietals are thus small. The frontals are moderately large, but much smaller than in *Struthiocephalus*. Unfortunately in the specimen much of the

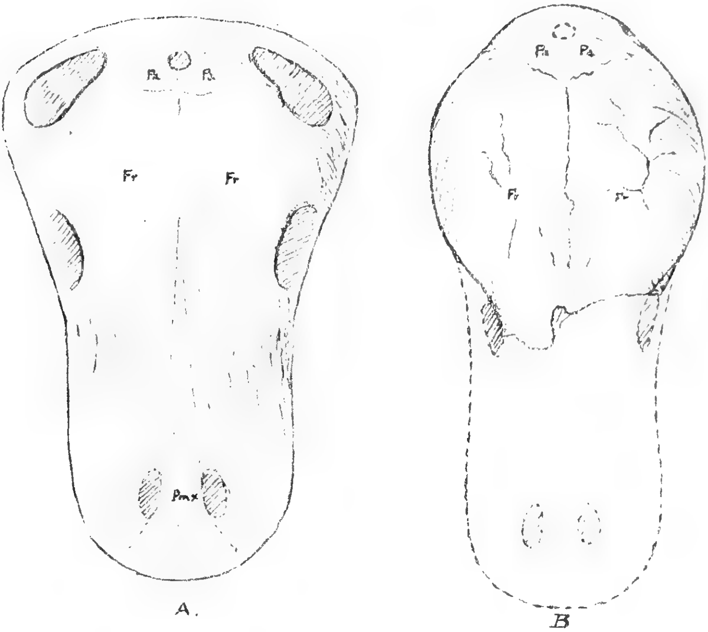

FIG. 6.—A, upper view of skull of *Taurocephalus lerouxi*. × about $\frac{1}{7}$; B, upper view of skull of *Criocephalus vanderbyli*. × about $\frac{1}{7}$. Restored.

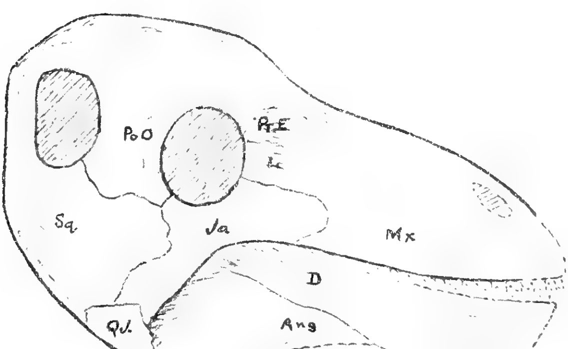

FIG. 7.—Side view of skull of *Taurocephalus lerouxi*, Broom About $\frac{1}{7}$ natural size.

surface of the frontals has weathered off. The squamosal is large and resembles that of *Delphinognathus.* It has a very large subtemporal portion which articulates with the postorbital and jugal. The quadratojugal is small, and there is no fenestra between it and the jugal. The jugal is long and extends considerably in front of the plane of the orbit.

The maxillae are long and have numerous small teeth. The premaxillae are not well preserved. Between the nasals they send a very long median process back to near the top of the skull—possibly even dividing the frontals. Unfortunately the sutures on the top of the skull other than those shown in the figure cannot be made out.

Portions of the lower jaw are preserved, but it is very imperfect and badly weathered.

Criocephalus vanderbyli gen. et sp. nov.

This new genus and species is founded on the top of a skull discovered by Mr. W. van der Byl at Abraham's Kraal. Though the specimen consists of only the frontals, the parietals, the postfrontals, the prefrontal of one side and apparently much of the postorbital of one side, the parts preserved indicate an animal very different from any hitherto known, and I have much pleasure in naming it after Mr. W. van der Byl, who has been for so many years one of our most enthusiastic and successful collectors.

As will be seen from the figure given, the frontals are greatly enlarged and form a huge rounded boss on the top of the skull. The width of this large boss is 246 mm. Much of the right temporal fossa is preserved and the top of the right orbit. The orbits are close together, the interorbital measurement being only 130 mm. The front of the skull must thus have been narrow.

8. *On some New Mammals from the Diamond Gravels of the Kimberley District.*—By R. Broom, D.Sc., F.R.S.

(With 3 Text-figures.)

Along the valley of the Vaal River there are many terraces at various heights above the river, and many of these terraces are diamondiferous, and these have in places been very thoroughly washed in the search for diamonds. In many of the deposits mammalian bones and teeth have been found, but it is only recently that the value of these specimens has been fully realised.

For some years Miss Wilman of the Kimberley Museum has been collecting teeth found by the diamond diggers, and from these Haughton has described a new species of elephant and an animal which he believes to be allied to the giraffe.

In 1925 I described the third lower molar of a giant pig which I came across in the Port Elizabeth Museum. This specimen came from the Diamond Gravels of the Vaal River near Longlands. I made the tooth the type of a new genus and species *Notochoerus capensis*, and regarded the animal as allied to the wart-hog *Phacochoerus*, but much more primitive.

Two large molars were sent to Osborn by Miss Wilman, at my suggestion, and these have been identified by him as representing two species of *Archidiskodon*, the one a lower Pleistocene type and the other probably a Pliocene type.

Recently other interesting teeth have been discovered, and four new mammals represented are here described.

Notochoerus meadowsi sp. nov.

This new pig is represented by a well-preserved last lower molar of the left side. It agrees sufficiently with the molar of *Notochoerus capensis* to suggest the advisability of retaining it in the same genus, but it certainly represents a very distinct species.

The tooth is made up of two rows of long pointed cusps with between them a median row of smaller cusps. The shape and arrangement of these cusps will be most readily understood from the

figures given. As will be seen, the outer and inner cusps are six in number, and the anterior ones considerably convoluted and the posterior much smaller and rounded. The median cusps are slender and rounded.

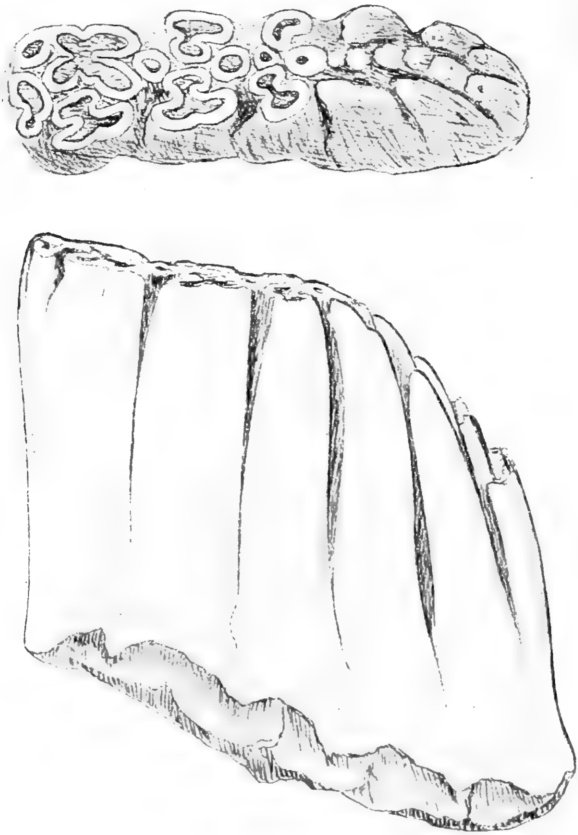

Fig. 1.—Third lower molar of *Notochoerus meadowsi*, Br. Natural size. Upper view and outer view.

There are considerably more cusps in this tooth than in that of *N. capensis*, and *N. meadowsi* thus comes a little nearer to *Phacochoerus*.

The following are some of the principal measurements :—

Greatest antero-posterior length at base of the cusps	76 mm.
Greatest width at base of the cusps	19 ,,
Width across anterior pair	16 ,,
Height of 3rd inner cusp	about 65 ,,

There is another allied form to which reference must be made. In September 1926 Hopwood described a pig molar from near Victoria Nyanza under the name *Metridiochoerus andrewsi.* Although Hopwood's animal is much smaller than *Notochoerus capensis* and a little smaller than *Notochoerus meadowsi,* it seems probable that it also belongs to the genus *Notochoerus*; and as the Victoria Nyanza beds are of Pliocene age, not improbably some of the teeth from the diamond gravels will also prove to be Pliocene.

I have named the new species after Mr. R. L. Meadows, the discoverer of the specimen.

Equus harrisi sp. nov.

A considerable number of horse teeth have been found in the gravels and they certainly represent a number of different species.

About twenty years ago I named a South African fossil horse *Equus capensis* from a lower jaw washed up by the waves from some deposit in Table Bay. As only the lower teeth are known, I have at different times referred upper molars provisionally to *Equus capensis,* and possibly erroneously. The teeth of the type specimen have never been figured. As it was impossible to deal with the diamond gravel horses till a further study had been made of *Equus capensis,* I recently when in Capetown made careful drawings of the teeth.

The lower molars of *Equus capensis,* as will be seen from the figures given, are exceptionally large—very much larger than the corresponding teeth of *Equus caballus.* There are also a number of differences in the enamel patterns, and it is possible that *E. capensis* may yet prove to belong to a different genus.

In the diamond gravels of the Middle Terrace at the Bend near Barkly West are found teeth of a large horse agreeing in some respects with *Equus capensis,* but smaller and manifestly belonging to a distinct species. Two lower molars may be taken as the type, and an upper molar found in association almost certainly belongs to the same species.

The 4th premolar differs from that of *Equus caballus* in having the outer pillars much more powerfully developed, and in having no trace of the folding seen on the front of the posterior outer pillar. There are a number of other points of difference that can be observed in the figures. The enamel round the inner pillars is strongly developed.

The 2nd lower molar differs from that of the modern horse in having the posterior inner pillar much more powerfully developed

and in the absence of the folding on the front of the posterior outer pillar. In both these points it agrees with *Equus capensis.*

The 4th upper premolar, which almost certainly belongs to the

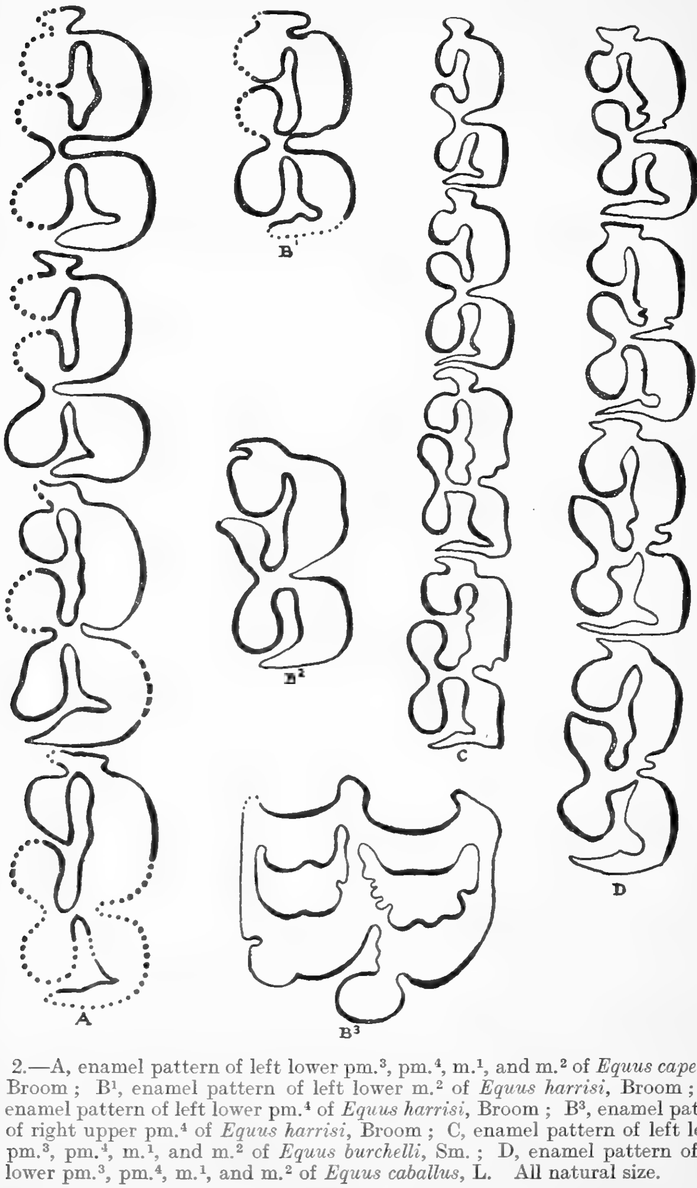

FIG. 2.—A, enamel pattern of left lower pm.^{3}, pm.^{4}, m.^{1}, and m.^{2} of *Equus capensis*, Broom; B¹, enamel pattern of left lower m.^{2} of *Equus harrisi*, Broom; B², enamel pattern of left lower pm.^{4} of *Equus harrisi*, Broom; B³, enamel pattern of right upper pm.^{4} of *Equus harrisi*, Broom; C, enamel pattern of left lower pm.^{3}, pm.^{4}, m.^{1}, and m.^{2} of *Equus burchelli*, Sm.; D, enamel pattern of left lower pm.^{3}, pm.^{4}, m.^{1}, and m.^{2} of *Equus caballus*, L. All natural size.

same species, presents a number of points of interest. The posterior portion of the anterior inner pillar—the protocone of American writers—is much smaller and more rounded than in most species of *Equus*, while the posterior and inner pillar is only very slightly marked off from the rest of the tooth by a small shallow posterior fold. Each of these suggests affinity with the Pliocene horses rather than with the later species of *Equus*.

It seems probable that *Equus harrisi* is, like one of the species of *Archidiskodon* found in the same deposit, a Pliocene type.

I have named the species after Mr. J. R. Harris.

Equus cawoodi sp. nov.

This new species of *Equus* is founded on a 4th upper premolar of a large horse discovered in the Diamond Gravels at Winter's Rush by

A. B.

FIG. 3.—A, 4th upper molar of *Equus cawoodi*, Br.; B, 4th upper molar of *Equus kuhni*, Br. Both natural size.

Mr. J. J. Cawood. A portion of the root is broken off, but when perfect, even with an unknown amount of the grinding surface worn off, it must have measured 90 mm. in height. Anteroposteriorly the greatest measurement is 32 mm., and the greatest transverse measurement over the cement is 34 mm., or across the enamel 31 mm. In the slightly oblique worn surface the anteroposterior measurement is 33 mm.

It will be seen that the tooth is a little larger than that of the average *Equus caballus*. As will be seen from the figure given of the enamel pattern, there are a considerable number of differences from the corresponding tooth of a living horse. The antero-internal pillar—the so-called protocone—is much more greatly developed anteroposteriorly than in *Equus caballus*, while the posterior-internal pillar is also more developed, and practically extends to the plane

of the posterior enamel plate. Other differences of a less important degree will be seen by comparing the tooth with that of the living horse.

The tooth as received is somewhat water-worn. It is completely fossilised. It is, however, probably much more recent than that of *Equus harrisi*. Not improbably it is a Mid-Pliocene type. The type tooth is No. 3711 M'Gregor Museum.

Equus kuhni sp. nov.

This new species is founded on a beautifully preserved 4th upper molar discovered by Mr. G. Kuhn at Pniel. It is the tooth of a horse allied to *E. cawoodi*, but a little smaller. The protocone resembles that of *E. cawoodi* but is considerably shorter anteroposteriorly and thus a little nearer to *E. caballus*, but it differs from that of *E. caballus* in being much flatter. In a number of ways it approaches the American Pleistocene species *Equus complicatus*. The antero-posterior measurement of the tooth is 31 mm., and the greatest width across the enamel is 29·5 mm.

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